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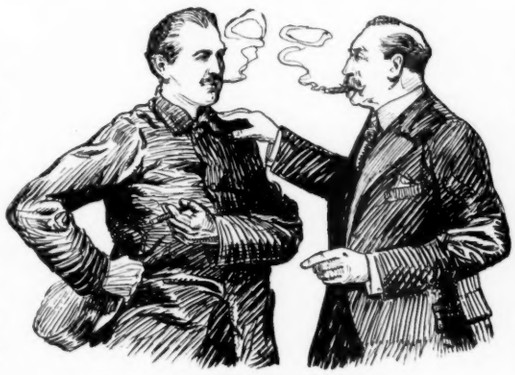
How Engineer Tim Got a Raise of Pay and Promotion



Contributed by M. E. GRIFFIN

TIM had been chief operating engineer in a cotton mill for fifteen years, and during that time had received only one raise of pay, and that mainly because of his heroic work during a fire.

Some time ago he decided to ask for a raise. Nerving himself for the ordeal, he finally had courage enough to go to the manager's office and in a straightforward way stated his case. The manager answered that the firm always recognized him as a good, faithful, conscientious engineer and felt proud of the care he took of the power plant, but owing to the increased cost of material and generally high running expenses, it was not possible to raise his pay, at least at that time.

Tim returned to the engine room somewhat downhearted, but he knew that it would be useless for him to try for a job elsewhere, as the pay would not be greater and he would have to start in on a new job with machinery perhaps new to him, whereas he knew all about his present power equipment

TIME AND AGAIN he asked himself the question: *"How can I make myself more valuable to my employers and in turn get more pay for increased efficiency?"* He had been reading many articles on how engineers increased the efficiency of their plants and decided that perhaps it was possible for him to do likewise. It was true that his engines always ran well and none had better care, the firm often remarking on the low cost of repairs.

The power plant consisted of one 600-hp. cross-compound Corliss engine and a 250-hp. single-cylinder Corliss, each noncondensing and belted to separate lineshafts. There was also a 600-ft. steam-driven air compressor of old design, which was always considered a "steam hog." Air pressure was 80 lb. and steam pressure on boilers 125 lb. gage.

Tim purchased a book on engine testing and learned how to figure steam consumption from indicator cards, because he wished to make a test and ascertain if his plant was as efficient as it should be.

He had no means of measuring steam because his plant was noncondensing and to "rig up" would cost too much for equipment—more, he knew, than his firm would allow—therefore steam consumption from indicator cards was the nearest he could approach true conditions.

While he was making elaborate preparations for indicating the different units, he became so enthusiastic that he even gave the office boy a package of cigarettes for spreading the news around the office that great "doings" for increased efficiency were going on in the power plant.

THE CARDS from the cross-compound were very good, showing good distribution of steam and figured 20½ lb. of steam per indicated horsepower-hour, which was relatively close to the engine builder's guarantee.

The single-cylinder engine's cards, while showing good valve setting, figured 29 lb. of steam per i.hp.-hr., which was very much higher than builder's guarantee. This was accounted for by the early cutoff shown on the cards, proving that this engine was considerably underloaded and therefore wasteful accordingly.

The air-compressor cards figured an average of 37 lb. steam per i.hp.-hr. and showed a cutoff of about 75 per cent. of the stroke, which meant that the work done by the expansion of steam was practically nothing.

Summing up the steam consumption for the three units, 20½ lb. + 29 lb. + 37 lb. = 86½ lb. of steam per i.hp.-hr., and as the coal had an evaporation value of one pound of coal per 7½ lb. of steam, it was no wonder the firm was complaining about the monthly coal cost.

This convinced Tim that, while for fifteen years he thought he had an economical plant, he was only fooling himself and incidentally throwing his firm's money into the boilers, as he termed it.

After a couple of days' thought, he asked permission to make a few changes that he believed would increase the efficiency of the power plant with very small expenditure of money, stating that he could do the work himself at "odd" times. The superintendent gave him permission to do anything within reason that would reduce the coal consumption.

TIM REASONED THUS: "The cross-compound is the only economical unit, and I'll leave it alone; the single-cylinder is underloaded, and I'll have to build up a load somehow; the air compressor is overloaded and playing h— with the coal pile."

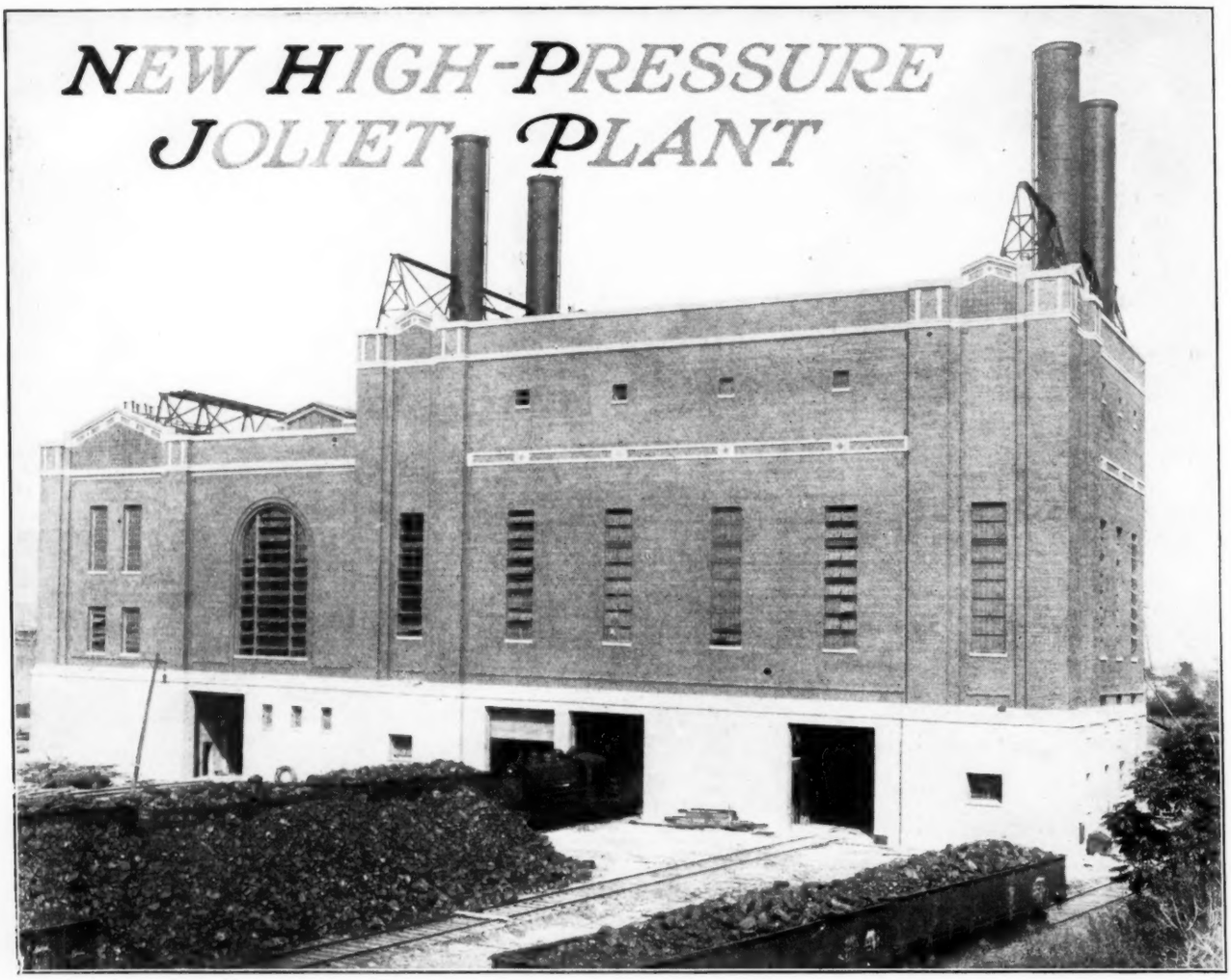
On the air compressor there were two balance wheels, each wide enough for a belt to drive it and so located that it could easily be belted to the lineshaft driven by the single-cylinder engine. This seemed like an inspiration. He took the steam piston out of the air compressor and turned it down with a groove to hold babbitt and babbitted the lower circumference one-third the way around so as to act as a tail-rod crosshead, using the steam cylinder with heads removed as a tail-rod guide. He then procured a pulley of suitable size and mounted it on the lineshaft driven by single-cylinder engine, belted up the air compressor and shut off its steam line, letting the single-cylinder Corliss drive the belted air compressor.

His new set of indicator cards from the single-cylinder unit, while showing a slight overload, figured a fairly economical steam consumption and good distribution of steam and the 37 lb. per i.hp.-hr. of the air compressor was a thing of ancient history. Tim was the happiest man in North Carolina. Why?

ABOUT A WEEK after the change was completed, the manager sent for him. Tim was surprised at his offering him a cigar, and more so when he showed him a chart of coal consumption, week by week, covering year after year, and what the saving had been during the past week.

"Tim," said he, "you asked for a raise of pay a while ago, and we could not afford it, although we would willingly have granted it if conditions warranted it. We have been keenly interested in what you have been doing since, and the results are a revelation to us. You have initiative and can think for yourself. We are not going to give you a raise of pay as chief engineer." Tim began to feel sick at heart. After all his trouble, no raise! "No, not as chief engineer. At a directors' meeting this afternoon we appointed you general superintendent of this plant, your duties to begin at once, and you have free rein to use your best judgment in increasing the efficiency of any and every department according to your own ideas. You are the efficiency expert we have been advertising for and could not locate."

NEW HIGH-PRESSURE JOLIET PLANT



Boilers designed for 350 lb. pressure will deliver steam to the turbines at 300 lb. gage and 225 deg. F. of superheat. An all-steel horizontal-tube economizer is placed above and integral with each boiler. Extra-heavy piping, special welded joints and steel fittings are employed. First 10,000-kw. unit is now in operation and second under erection.

TO CARE for a rapidly increasing load in a territory covering thirteen counties, the Public Service Co. of Northern Illinois is adding the new Joliet plant, shown in the headpiece, to its list of generating stations. It is situated about three miles south of the city on the Des Plaines River, on 40 acres of land between the Atchison, Topeka & Santa Fe and the Chicago & Alton railroads. This location is adjacent to two railroads tapping the coal fields of Illinois and has at hand an abundant supply of water. A property plat is shown in Fig. 1. The initial portion of the station is to contain two 10,000-kw. generating units. Later, as the load demands, the building will be extended to accommodate additional and larger units.

In the new plant the outstanding feature is the high steam pressure—300 lb. at the turbine and approximately 325 lb. at the boiler, superheated 225 deg. This is about 75 lb. higher than common in modern stationary practice and is a notable step in the recent movement to improve economy by raising the upper limits of the cycle. It seems generally agreed that in the condenser there is little more to be gained. Higher steam temperatures to widen the operating range up to the limitations of the metal employed and the construction of the equipment offer the greater opportunity.

Although the boilers are of the standard Babcock & Wilcox cross-drum type, they are built heavy to withstand the high pressure. The plates in the boiler drum are $1\frac{5}{16}$ in. thick, the longitudinal seam being a butt and double cover strap quadruple-riveted joint. The heads are secured by two rows of rivets. Tubes of No. 7 gage, as compared to No. 10 for 200-lb. pressure, are used. All high-pressure steam piping is extra-heavy and of relatively small diameter owing to the density of the steam. With steam at a temperature of 650 deg. rigid construction was avoided. The length of straight runs has been limited, and numerous long-radius bends are employed to provide for expansion. All fittings are of steel, the manifolds used in connection with the boiler leads having been cast and the smaller fittings forged. On pipes above 4-in. diameter a special bolted joint with a welded seal at the periphery is used.

A notable feature is the installation of individual all-steel horizontal-tube economizers, the first of their

kind in this country. The economizer is placed above and integral with the boiler. The economizer tubes have a 5-deg. slope. With no dampers between, so that the gases pass directly from one to the other, it is really one stage of the boiler unit. See Fig. 3. Furnace gases pass from the economizer at such low

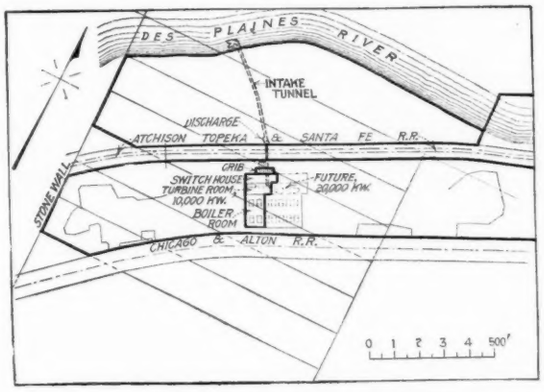


FIG. 1. PROPERTY PLAT, JOLIET STATION

temperatures as to permit unlined steel stacks, the latter being coated with an asphaltic paint adapted to high temperatures.

Another feature of the plant is a basement entirely above ground, the main operating floor being the second story of the building. A solid rock footing was already available and excavation would have been costly. Besides, the construction gives headroom for the coal and ash cars operating at the ground level and eliminates ash conveyors. There is gravity flow from the overhead coal bunker to the stokers, and the ashes are delivered directly from the hoppers under the stokers to railway cars.

Outside of the small stoker engines held as reserves for motor drives, there is no reciprocating machinery in the station. All pumps are of the centrifugal type and motor-driven with the exception of the boiler-feed and one service pump operated by turbines. With little exhaust steam available to heat the feed water, provision is made to bleed steam under thermostatic control from the fourth stage of the main turbine, where the pressure is sufficient for this purpose. Another feature is to utilize the condenser for drawing boiler makeup from the fresh-water reservoir. The water enters the condenser and with the aid of the condensate pump is passed in the usual way to the heater.

With the compact arrangement of boiler and economizer and the steel casing over all, radiation and air leakage should be reduced to a minimum. An exceptionally high boiler efficiency should be maintained.

Architecturally, the building is substantial and of pleasing design, as the headpiece of this article shows. A skeleton steel frame supports walls of vitrified brick resting on concrete base walls. Floors are of reinforced concrete. In the turbine room the walls are lined with white glazed tile with a 5-ft. dado of dark-green tile. In plan the building is irregular with maximum dimensions of 134 x 244 ft. As the entire plant is above the ground level, the height is greater than usual. The basement floor is about six inches above ground level, the boiler-room floor is 28 ft. higher and to the top of the monitor roof an additional 60 ft. Under the turbine room is a 22-ft. basement. The height from the main floor to the crane rail is 30 ft., and the clear space to the bottom of the roof girders measures 40 ft. At one end of the building are temporary walls so that the station may be extended easily for additional equipment.

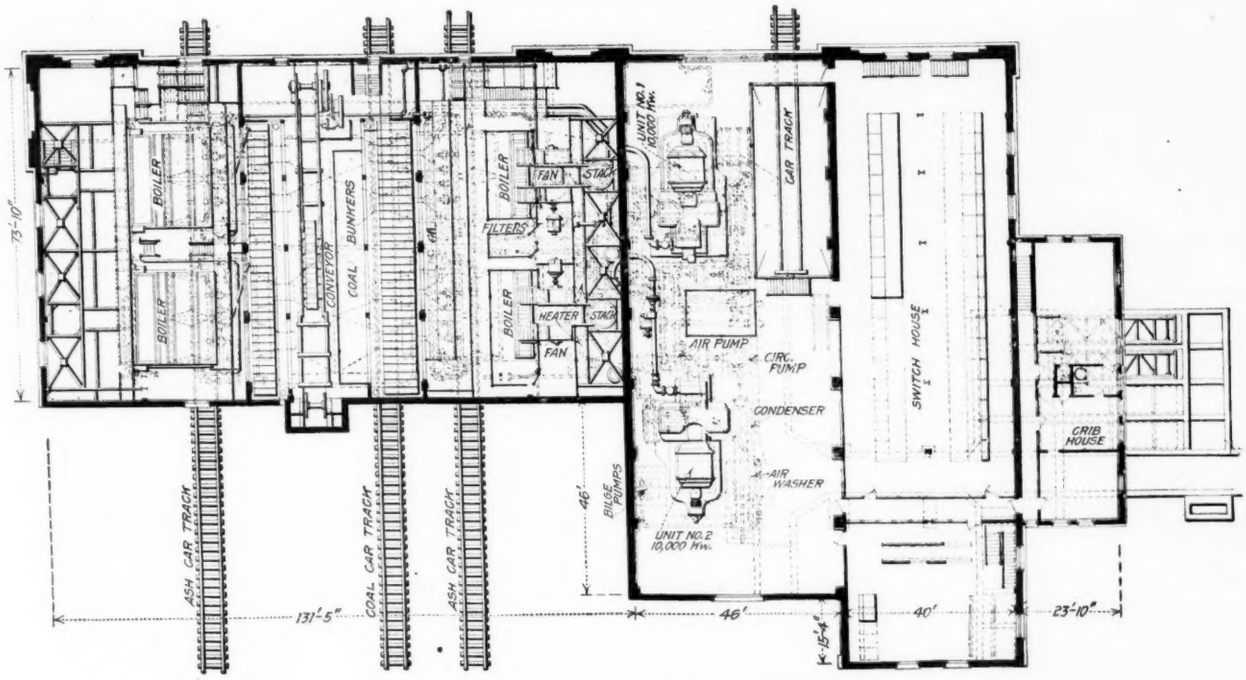


FIG. 2. GENERAL PLAN OF STATION

The station is arranged on the unit plan. For each 10,000-kw. generating unit there will be two cross-drum water-tube boilers, each having 9919 sq.ft. of steam-making surface, a built-in superheater with 3100 sq.ft.

and an economizer containing 6730 sq.ft. of surface. There are now three boilers in the plant, but when the second generating unit is installed, a fourth boiler will be added. Under ordinary conditions when a good grade of Illinois coal is available, it is the intention to use three boilers to carry the two generating units, leaving one boiler in reserve. With inferior coal the four boilers will probably be needed.

With three boilers serving two generators there will be 1.49 sq.ft. of active steam-making surface per kilowatt of generating capacity, or on the basis of 10 sq.ft., one boiler-horsepower will serve 7.67 kw. This does not take into account the economizer. Each boiler, with its steel casing, masonry setting and retreating back, covers at the floor line an area of 294 sq.ft., or 0.296 sq.ft. per horsepower (10 sq.ft.) of rating. Including the overhang the area increases to 0.472 sq.ft. per horsepower, and to the stoker fronts the floor space

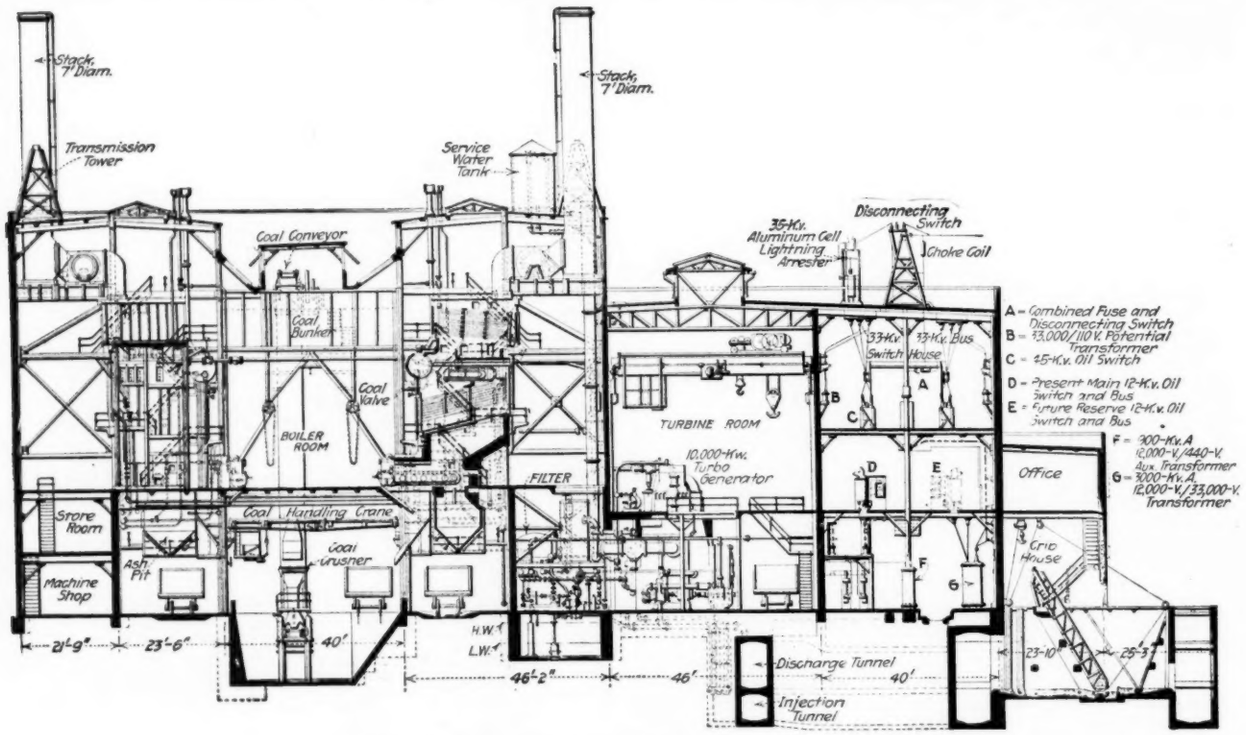


FIG. 3. SECTIONAL ELEVATION THROUGH PLANT

covered is 585 sq.ft., or 0.59 sq.ft. per horsepower. From the boiler-room floor to the center of the cross-drum the height is 26 ft. 6 in., and 42 ft. from the floor to the top of the economizer.

A very interesting feature is the stoker installation. Two chain grates are placed side by side in a common furnace, each being 8 ft. wide, 14 ft. 6 in. long and containing 116 sq.ft. of active grate area. Double this area bears a ratio to the steam-making surface in the boiler of 1 to 43. The stokers are motor-driven through reduction gears and belt, with vertical engines in reserve. The general design of the setting and the positions of the economizer and induced-draft motor-driven fan are shown in Fig. 3. Rising 65 ft. above the fan, or 125 ft. above the grate, is an individual self-supporting steel stack of 7 ft. diameter. Owing to the low temperature of the flue gases leaving the economizer (probably 350 deg. F.), the stack is unlined, an asphaltic paint on the interior surface protecting the metal.

Being the first of its kind in this country, the economizer is of special interest. The construction is similar to that of a B. & W. type boiler without the drum. The headers are of wrought steel and the tubes, which are 4 in. diameter and 16 ft. long, of drawn steel $\frac{1}{4}$ in. thick. As low temperatures are expected, the tubes are galvanized inside and out to guard against corrosion. The economizer is vertically baffled for three passes, the gases from the boiler entering at the front and from the third pass rising vertically through the induced-draft fan to the stack. The fan has capacity to handle 75,000 cu.ft. per min. of gas at 350 deg. F. At this rating the power required is 94 hp. To give plenty of reserve capacity for contingencies and to reduce upkeep to a minimum, a 150-hp. motor was installed. In general this policy of using motors of liberal capacity for the work has been adopted all through the station. Water to the economizer enters at the bottom of the rear header and passes through 396 four-inch tubes to leave at the top of the front heater. The relative flow of gas and water is thus counter-current.

Reviewing the foregoing data, it will be seen that each 1000 sq.ft. of boiler-heating surface has 23.4 sq.ft. of grate, 313 sq.ft. of superheating surface, 678 sq.ft. of economizer and 3.88 sq.ft. of stack.

Feed water for the boilers is mainly condensate which has been delivered through a preheater at the top of the condenser, containing 1000 sq.ft. of surface to the heater by either one of two motor-driven condensate pumps, the duplication tending to insure continuity of service. The heater is of the open type, having capacity to serve the two boilers of the unit. Either of two four-stage turbine-driven centrifugal pumps designed

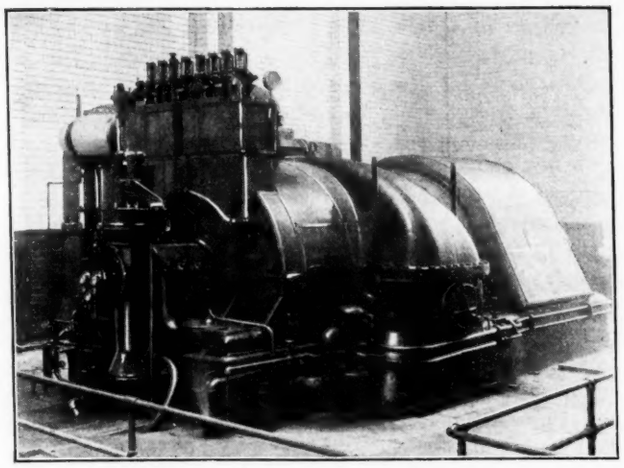


FIG. 4. TURBO-GENERATOR NOW IN OPERATION

to deliver 300 gal. per min. against a head of 375 to 400 lb., feeds the water to the boilers. The turbines are rated at 126 hp. and operate under full boiler pressure, their output being controlled by pressure-regulating valves. The water passes through the economizer and enters the boiler at both ends of the cross-drum.

The makeup water comes from a fresh-water reservoir which collects the steam-header drips, heater over

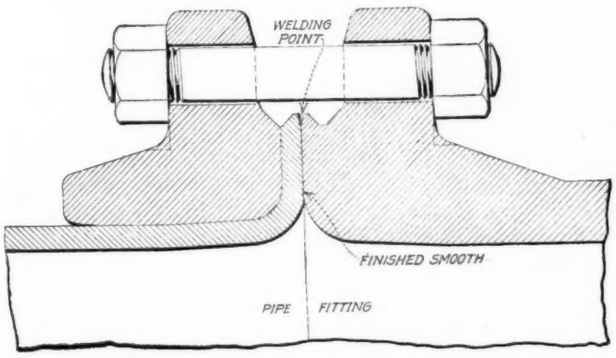


FIG. 5. CONSTRUCTION OF SPECIAL WELDED JOINT

flow and other other available condensation. Under float control it is also supplied with filtered service water. The house-service water supply is drawn from the condenser intake tunnel by two 600-gal. pumps, one driven by a turbine and the other by a motor. It is delivered to a service tank on the roof. From the pump discharge line several taps are taken off for transformer cooling and for various services where raw water can be used. Return water from the tank passes through duplicate pressure filters, each of which has capacity to filter 150 gal. per min. Upon leaving the filter the water supply divides, part going to cool bearings and to the lavatory system, and the balance as needed to the hot-water reservoir. The vacuum on the main unit is utilized to draw the makeup water from the reservoir into the condenser, the amount being regulated by a float in the heater. It is removed by the condensate pump in the usual way and delivered to the heater.

With the exhaust steam available the water temperature in the heater under average load conditions will probably range from 100 to 120 deg. F. To maintain the temperature within this range a bleeder connection under thermostatic control has been made to the fourth stage of the turbine.

Coal for the plant, Illinois lump and screenings, is brought in over the company's siding from the Chicago & Alton tracks at Plaines, about three-quarters of a mile distant. The company has its own locomotive and coal cars and at the plant a yard containing five tracks. No. 1 is a storage track running past the south side of the building, Nos. 2 and 4 are ash tracks serving the two rows of boilers, No. 3 is the coal track, and No. 5 serves the turbine room. Between these tracks there is space to store about 10,000 tons of coal. Track No. 3, centering on the firing aisle, leads into the boiler-room basement over a concrete pit capable of storing 800 tons of coal. By a four-motor traveling crane with a 2-yd. grab bucket the coal is unloaded into a four-roll traveling crusher, driven by a 50-hp. induction motor, which discharges to a bucket conveyor delivering into the overhead bunker. The latter has capacity to hold 450 tons, or 112 tons per boiler. The bunker is made up of steel plates, concrete lined, and is divided up into four compartments with double chutes from each leading to the two stokers under their respective boiler.

Screenings are handled in the same way with the exception that the rolls of the crusher are spread to allow the coal to pass through to the conveyor. On both sides of the crusher are bypass chutes to the storage pit. The coal may be unloaded into the pit or into the outdoor storage space. In the latter case a locomotive crane unloads the coal and loads it again when it is desired to remove it to the plant.

Under each boiler furnace are ash and fine-coal hoppers. The former is brick lined and is equipped with a sprinkling system to wet down the ashes. Through a sliding gate operated by a handwheel, the ashes are passed directly to railway cars, thus obviating the need of ash-handling apparatus, always hard to maintain. Farther forward, under the stoker, is the fine-coal hopper, which delivers its contents to the con-

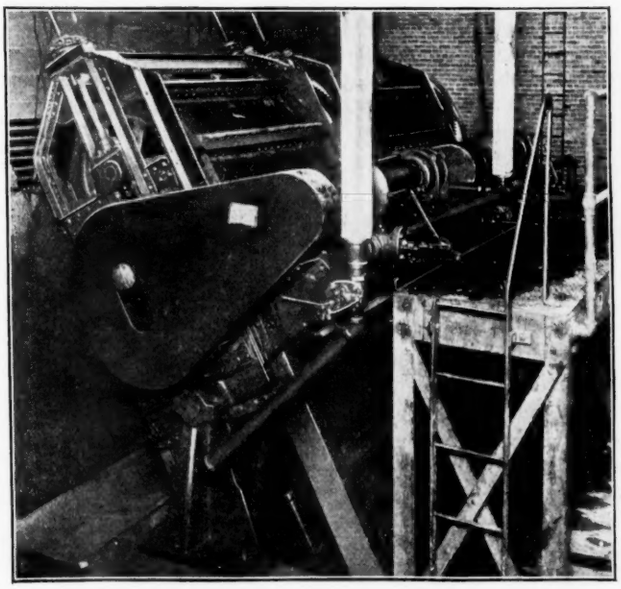


FIG. 6. TRAVELING SCREENS FOR COOLING-WATER INTAKE

crete storage pit. The outlet is controlled by a sliding gate operated from the boiler-room floor.

As previously explained, all high-pressure piping is extra-heavy, with fittings of cast or forged steel. On pipes above 4 in. diameter the special-welded joint shown in Fig. 5, is used. The pipe is extended through the flange and is belled out to form the face of the joint. The face is finished smooth, and the edge beveled off to form a V-shaped groove to receive the welding metal. On fittings a facing boss of extra thickness to form a welding surface similar to that on the pipe flange is provided. The weld is intended only to seal the joint, the bolts through the flange taking the stress. In the plan view, Fig. 2, the numerous bends in the

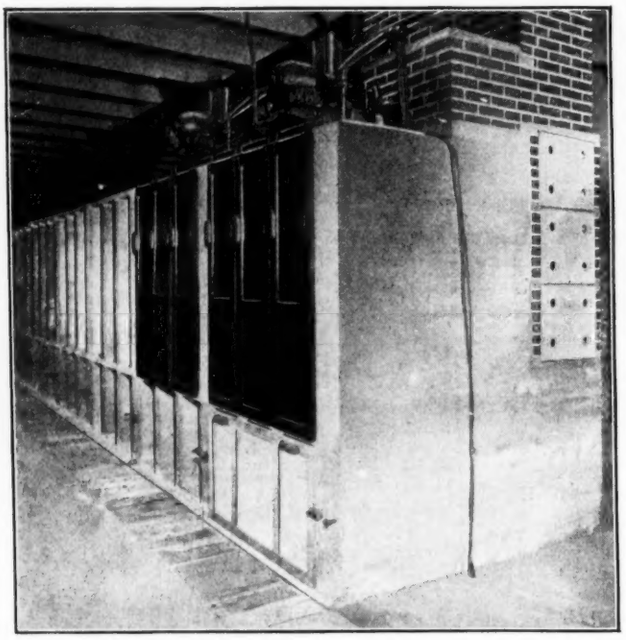


FIG. 7. OIL SWITCHES AND BUS COMPARTMENT

piping to care for expansion may be noticed. From each end of the superheater there is a steam outlet, the leads from the superheater being joined by special steel manifolds at the boiler-room wall. Two boilers per turbine will be provided, but there are cross-connections between the two units so that three boilers may be used to carry the two 10,000-kw. machines. The fourth boiler provides a reserve needed at times of cleaning or inspection.

The main generating units of the present installation are rated at 10,000 kw. at 80 per cent. power factor. One of these is shown in Fig. 4. At the turbine the working pressure is 300-lb. gage. The speed is 1800 r.p.m. The generators are three-phase 60-cycle machines delivering current at 12,000 volts, which is standard in the company's newer plants. In the electrical end of the plant no radical departures from standard practice have been made. Distribution will be at 12,000 and 33,000 volts. A double bus system is employed throughout the station. Each generator may feed through either of two oil switches to a set of sectionalized 12,000-volt double busses. From these busses two kinds of leads are taken off; one class being the 12,000-volt feeders and the other leading to the low-tension side of water-cooled transformers, stepping up the voltage to 33,000. Fig. 7 shows oil switches and the bus compartment.

Control of all electrical equipment except auxiliary power is effected from an operating room in the switch-house located on the turbine-room floor and separated from it by a glass partition. Generator control is centered in a benchboard, and outgoing feeders are controlled by vertical boards arranged with the bench-board in the form of a hollow square. Auxiliary 440-volt power has remote mechanical control from a vertical board in the turbine room. The generator circuits are equipped with overload relays, ordinarily connected in circuit only during synchronizing, and each outgoing line has a polyphase watt-hour meter. Of the latter liberal use has been made throughout the station. Excitation is effected by 100-kw. 250-volt shunt-wound exciters mounted on the generator shafts and a 100-kw. turbine-driven reserve exciter.

Over all the main unit is 33 ft. 6 in. long and 13 ft. 3 in. wide, requiring a floor space of 444 sq.ft., or 0.0444 sq.ft. per kilowatt of rating. The height of the unit is 12 ft. above the floor line. The turbine is served by a two-pass condenser containing in 3600 one-inch tubes 20,000 sq.ft. of surface. From the foregoing figures there is 2 sq.ft. of surface per kilowatt of generating rating.

Circulating water is supplied by a centrifugal pump having capacity to deliver 18,000 gal. per min. In conjunction with the Leblanc air pump it is driven by a 200-hp. slip-ring induction motor. Duplicate condensate pumps are used, each rated to care for 360 gal. of condensate per minute and driven by a 25-hp. motor.

Cooling water for the condensers is drawn from the Des Plaines River through a concrete tunnel, the intake being 570 ft. distant from the center line of the tunnel in the turbine room. In its course to the plant the tunnel passes under the Santa Fe tracks to the screenhouse, its dimensions to the river side of the railway being 10 ft. wide by 8 ft. high. From this point on to the plant it is 8 x 8 ft. in section. Water from the tunnel enters the forebay in the screenhouse, Fig. 6, where it first passes through an iron grid of $\frac{1}{4}$ x 4-in. bars designed to keep back driftwood which may have escaped the log boom at the intake. Revolving screens are then encountered, which measure 26 ft. 9 in. between centers of the driving sprockets and 5 ft. 2 in. wide between roller centers. Through reduction gearing each screen is driven by a 5-hp. induction motor. Provision is made to swing the screens to a horizontal position for inspection or repairs. Cleaning is done during operation. Water from slotted pipes is forced at high velocity through the mesh, discharging against splashboards and draining down into a trough leading to the discharge tunnel.

Back of the traveling screens are double sets of stationary screens having $\frac{1}{2}$-in. mesh to catch fibrous material, small fish or débris of any character remaining in the water. These screens are made up in sections 5 ft. 10 in. wide by 4 ft. 6 in. high. For cleaning they are removed by a hand-operated beam trolley. The discharge tunnel, 8 x 8 ft. in section, travels on top of the injection tunnel as far as the river side of the railway. Here it turns downstream and discharges into a swampy tract bordering on the river. At the turn

a 2-ft. 8-in. by 3-ft. 8-in. tunnel leads from the main discharge to the intake, where during the winter season the warm water will keep down the ice. A sluice-gate valve determines the amount of water drawn off for this purpose.

Safety of the employees and congenial surroundings were features given special prominence in the design of the station. The engineer has a large roomy office, shower baths and locker rooms were provided for the help and excellent drinking water is piped from a near-by spring. In addition to the usual equipment, the station contains a machine shop, storeroom and a fuel engineer's office in which coal, the big factor in power-plant operation, will receive close attention. The station was designed by Sargent & Lundy, consulting engineers, and Von Holst & Fyfe were employed as architects. Of the operating company Samuel Insull is president; F. J. Baker, vice president in charge of operation and construction; George H. Lukes, general superintendent, and J. L. Hecht, mechanical engineer.

IMPORTANT DATA OF JOLIET STATION

Boiler Room

Type of boiler	B. & W. cross-drum water-tube
Setting	Masonry and steel casing
Number now installed	3
Steam-making surface, sq.ft	9,919
Steam-making surface installed per kw., sq.ft	2
Pressure for which boilers are designed, lb. per sq.in	350
Operating pressure, lb. per sq.in	325
Superheat, deg. F	225
Steam temperature, deg. F	650
Number of boilers per unit	2
Number of tubes per boiler	429
Length of tubes, ft	20
Diameter of tubes, in	4
Length of drum, ft.-in	23–10
Diameter of drum, ft	5
Stokers per boiler	2
Type of stoker	B. & W. chain-grate
Active area of two stokers, sq.ft	232
Ratio grate area to boiler-heating surface	1 to 43
Superheater surface (B. & W.), sq.ft	3,100
Floor space occupied by boiler, sq.ft	468
Floor space per 10 sq.ft. heating surface	0.472
Floor space by boiler and stoker	585
Floor space per 10 sq.ft. of heating surface	0.59
Height of boiler from floor to center line of drum, ft	26.5
Height of boiler from floor to top of economizer, ft	42
Capacity boiler, normal, lb. steam per hr	60,000
Capacity boiler, maximum, lb. steam per hr	94,000
Per 1,000 sq.ft. boiler-heating surface:	
Connected grate area, sq.ft	23.4
Stack area, sq.ft	3.88
Economizer surface, sq.ft	678
Superheating surface, sq.ft	313
Economizer	All-steel B. & W. horizontal
Number of economizers	One per boiler
Number of tubes	396
Length of tubes, ft	16
Diameter of tubes, in	4
Economizer surface, sq.ft	6,730
Induced-draft fan	Sturtevant multivane
Capacity of fan, cu.ft. gas per min	75,000
Horsepower of motor	150
Stack	Unlined steel, one per boiler
Stack diameter, ft	7
Height stack above fan, ft	65
Height stack above grate, ft	125
Coal	Illinois run-of-mine and screenings
Coal bunker	Steel, concrete lined
Capacity bunker, tons	450
Concrete pit storage, tons	800
Yard storage, tons	10,000
Locomotive crane	Browning
Traveling crane	Whiting, 2-yd. bucket, 150 tons per hour
Traveling crusher	Orton & Steinbrenner
Crusher capacity, tons per hour	125
Coal conveyor	Link-Belt continuous-bucket
Conveyor capacity at 45 ft. per min., tons per hour	120
Boiler-feed pumps	Worthington 4-stage, 3-in. centrifugal
Number of pumps	Two per unit
Horsepower of turbine drive	126
Pump capacity, gal. per min	300
Pump speed, r.p.m	2,550
Feed-water heater	Warren Webster open type
Heater capacity, lb. per hour	150,000
Number of heaters	One per unit
Pressure filters	2 per unit, New York "Jewel"
Capacity each filter, gal. per min	150
Service pumps, two, one turbine, one motor-driven, gal. per min., each.	600

Turbines

Maker	General Electric Co.
Type	Horizontal Curtis
Capacity, kw	10,000
R.p.m	1,800
Steam pressure, lb. gage	300
Superheat, deg. F	225
Floor space covered by unit, sq.ft	444
Floor space per kilowatt, sq.ft	0.0444

Condenser

Maker	Westinghouse
Number of tubes	3,600
Size of tubes, in. O.D	1
Surface in condensers, sq.ft	20,000
Surface per kw. gen. rating, sq.ft	2
Preheater top of condenser, surface, sq.ft	1,000
Circulating pump	Westinghouse centrifugal
Capacity circulating pump, gal. per min	18,000
Speed, r.p.m	690
Drive, induction-motor, hp	200
Air pump	Leblanc, driven by circ. pump motor
Condensate pumps	Motor-driven centrifugal
Number	2 per condenser
Capacity, gal. per min	360
Motor drive, hp	25
Screens	2 sets stationary and 2 traveling per unit
Traveling screens	Link-Belt Co.
Length, c. to c. of driving sprockets, ft.-in	26–9
Width c. to c. of rollers, ft.-in	5–2½
Drive, G.E. induction motor, hp	5

Generator

Maker	General Electric Co.
Capacity, 80 per cent. power factor, kw	10,000
Voltage	12,000
Cycles	60
Phases	3
Field poles	4
Speed, r.p.m	1,800
Exciter mounted on shaft	100 kw., 250 volt
Exciter, turbine-driven, reserve unit, kw	100
Crane, turbine room, Whiting, tons	75

Electrical

Oil switch equipment, 12,000 volt	General Electric
Oil switch equipment, 33,000 volt	Westinghouse
Switchboard	Westinghouse
Lightning arresters	General Electric

Size of Neutral Wire for a Three-Wire System

BY T. A. NASH

While it is the practice in some localities to invariably make the neutral of a three-wire system the same cross-sectional area as the outside wires, this procedure is not always followed. Where there is likely at periods to be excessive unbalance on the three-wire system—that is, where practically all the load will come on one side of the system with no load on the other side—the neutral wire then carries the same current as the outside wire. Hence if the condition just outlined is likely to occur, the neutral wire should be made the same size as either one of the outside wires.

Some engineers specify that where outside wires are No. 6 or smaller, the neutral wire shall be of the same cross-sectional area as the outside wires, but when the outside wires are larger than No. 6, the neutral may have two-thirds of the cross-sectional area of either of the outside wires. In some cases it is permissible to make the cross-sectional area of the neutral one-half that of either of the outside wires.

Obviously, when the neutral is of smaller cross-sectional area than the outside wires, it must be protected by a fuse of correspondingly small capacity, in which case if the unbalance of the load on the two sides of the circuit becomes excessive, the fuse is likely to melt and thereby all the lights, assuming that the load is all on one side of the circuit, will be extinguished. It is for this reason that some engineers adhere to the practice of specifying the neutral of the same cross-sectional area as the outside wires. There is no reason, however, why the neutral, provided it is properly fused, should not be smaller than the outside conductors.

One of the tendencies of today is to overdo the stop-watch and the watch-dog method. Efficiency of product does not lie in that direction. It is not right to imagine that the men have no other interest in the success of the work than to watch the hands of the clock go round.

Heavy-Duty, Diesel-Type Oil Engines for Marine Work

The McIntosh & Seymour Corp., of Auburn, N. Y., has built a number of 500-hp. heavy-duty, marine-type Diesel oil engines, for use on the Pacific Coast, one of which is shown in the illustrations. The engine

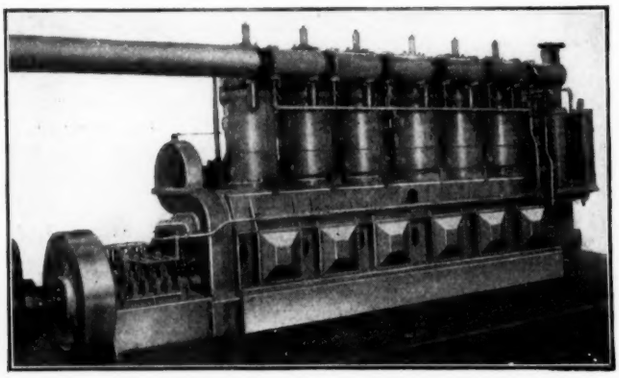


FIG. 1. ASSEMBLY OF ENGINE SHOWING CYLINDERS AND OVERHUNG FLYWHEEL

has six cylinders and is of the four-cycle type, single-acting and is directly reversible.

The air for atomizing the fuel for the working cylinders, also that required for maneuvering, is furnished by a three-stage compressor located at the forward end of the engine and directly driven from the engine. The compressor is built with intercoolers and aftercoolers. The valves and cages are all accessible and removable as a unit, making their removal and renewal a simple matter.

The thrust bearing, which may be of either the standard horseshoe-marine or Kingsbury type, is carried in a base bolted securely and doweled to the engine base, and contains a large bearing at its after end, making it possible to carry the flywheel overhung, as indicated in Fig. 1. The main working cylinders are bolted to the top of the engine frame and are of a simple design provided with removable liners. The heads are separate from the cylinders, each containing an inlet, an exhaust, a fuel and a starting valve. The gear for operating these valves is clearly shown in Fig. 2.

The camshaft, as can readily be seen, is carried in the housing bolted to the engine frame, and is driven by spur gears from the end of the crankshaft. From the forward end of the crankshaft a fuel pump and speed-limiting governor are driven.

The maneuvering gear, as can be seen, is at the forward end of the engine. The maneuvering is done in the proper sequence due to the interlocking feature of this device, thereby preventing the operator from damaging the equipment through a misunderstanding of its functions. The supply of oil, and consequently the control of the ship, is accomplished by one single lever. There is arranged a control lever within easy reach of the operator, which is devised to relieve the cylinder of any pressure, and when brought into operation, it automatically shuts off the atomizing air when the release valves are open.

The lubrication for the working cylinders, piston pins and compressor is effected by the use of a Richardson-Phenix force-feed lubricator driven by gears and suitably timed, so that the lubricating oil is delivered to the various parts during that portion of the cycle that is most beneficial. The oil for the crankpins, main bearings and other journals is supplied from a gravity system through gang oilers conveniently located. As the engine is entirely inclosed, the base having a bottom casting, the oil is all collected in the base from where it is pumped through a filter and then returned by gravity to the bearings. A small pump driven from the camshaft is arranged to automatically handle the oil and return it to the system.

The cooling system of this engine is so arranged that salt water can be used for cooling purposes without coming in contact with the steel studs or any part likely to be affected by it. It has the same effective cooling, however, as on stationary engines and the same even flow and proper circulation through the cylinder heads.

The average time consumed from full-speed ahead to full-speed astern for fifty maneuvers was eight seconds. Very likely this time can be somewhat reduced when the engines have become fairly limbered up and the operators are perfectly skilled in handling the equipment.

The fuel consumption of these engines is slightly over 0.4 lb. of fuel oil per horsepower-hour when operated at rated speed and load. It has been demonstrated that these engines are capable of a reduction in speed of 60 per cent. The air tanks supplied with the engine, which carry 300-lb. pressure, are of sufficient size to start the engine 44 times, the minimum starting pressure being 80 lb.

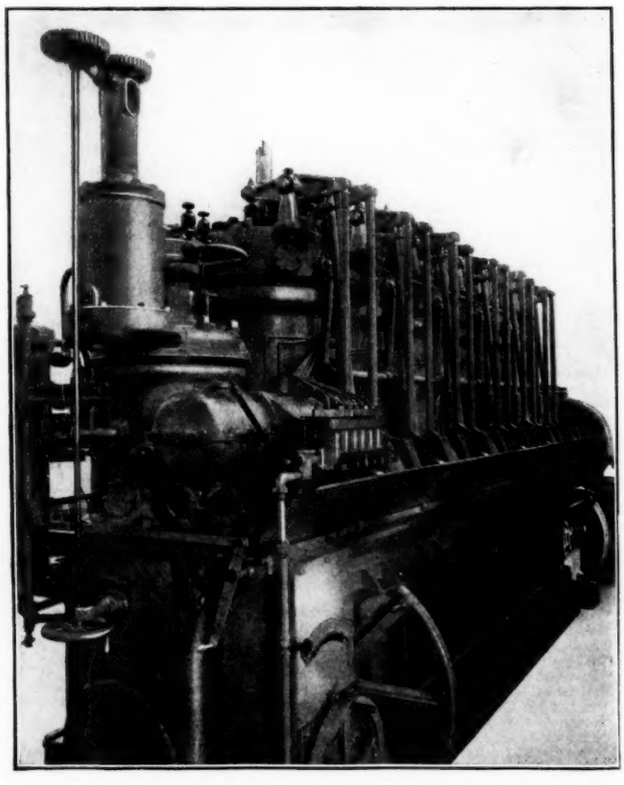


FIG. 2. ASSEMBLY OF ENGINE SHOWING VALVE GEAR

Fuel Consumption Control by the Government

By J. W. HENDERSON
Chief, Bureau Smoke Regulation, Pittsburgh, Penn.

The author proposes that the Federal Government assume absolute control not only of coal and its distribution, but of its consumption so as to conserve the supply. He believes the stoker should be adopted by most plants that the lower grades of coal may be burned. The Fuel Administration should be continued after the war, and the Bureau of Mines act as engineer for it. Specific cases of saving by better combustion methods are cited.

THE materials embraced by the term "Fuel" in this article are: Coal and its byproducts; wood and its distillates; oil; gas. The possible savings are conservatively estimated at $1,000,000,000 annually. The purpose is to offer evidence and argument in support of a recommendation that the Federal Government extend its work of conservation to include fuel consumption control and smoke regulation, and to suggest how this may be done. The proposition is that the Government shall go one step farther than is the case at present. It now regulates the production, distribution and price of fuel. There is equal or greater necessity for regulation of the methods of consumption.

The results of this work under Governmental control will be such as to (1) save fuel and (2) release men from nonproductive labor for productive effort; (3) increase the number of men available for war activities without interference with production in the industries; (4) increase the available freight-car tonnage without adding to the number of cars; (5) establish standards for fuel usage according to quality and applicability; (6) develop the coal-tar and other byproduct industries; (7) provide gas to replace the natural-gas shortage; (8) add to the supply of fuel for internal-combustion engines; (9) promote the production of fruits and vegetables; (10) protect the material welfare of the people; (11) conserve the health of the people.

All these things are possible and their attainment practicable and within the sphere of the powers of the Federal Government. In fact, no other authority in this country is available for undertaking this task with the consistency and permanency called for by the conditions. This is true in peace times as well as during the war. The reader's attention is called to quotations from a recent opinion of a Supreme Court Justice and a message to Congress of a former President as follows:

The Adamson Case, Wilson vs. New: Justice McKenna, concurring, "And submission to regulation is the condition which attaches to one who enters into or accepts employment in a business in which the public has an interest."

Special Message of President Roosevelt, Jan. 22, 1909: "The conservation of our resources is the fundamental question before this nation, and that our first and greatest task is to set our house in order and begin to live within our means. I do urge, where the facts are known, where the public interest is clear, that neither indifference and inertia, nor adverse private interests, shall be allowed to stand in the way of the public good. The freedom of the individual should be limited only by the present and future rights, interests and needs of the other individuals who make up the community. When necessary, the private right must yield, under due process of law and with proper compensation, to the welfare of the commonwealth. All this is simply good common sense. The underlying principle of conservation has been described as the application of common sense to common problems for the common good."

At this time not only the success of the war, but also the "permanent welfare of the people," is at stake. The "facts are known"; the "public interest is clear"; "adverse private interests" are ready and willing to yield to the necessities created by the war in which the country is involved; there is an awakened public consciousness to the need of conservation, and there is at hand the machinery of government capable of accomplishing the results outlined in the eleven items mentioned above.

1. Save Fuel

There are a number of ways in which fuel saving can be promoted. Upon the extent of fuel-consumption control and smoke regulation and the methods employed, will depend the accomplishing of the other items in the list of results. The work can be started immediately by compelling temporary changes to furnaces, pending further changes of fuel and equipment for permanent efficiency.

Emission of black smoke from stacks is a sure indication of waste. Prohibiting this smoke will result in proper firing methods, which alone will reduce the waste of fuel. The demand should be to stop hand-firing of boiler furnaces and other furnaces where capacity is beyond one-man-power. Mechanical appliances should be ordered at once, especially where the waste of fuel is most flagrant. Some governmental authority should also insist upon their proper use.

Smoke regulation and fuel-consumption control cannot be separated. Properly conducted, both lead to conservation in its broadest sense. A wider application of the term "smoke" would include zinc dust, ore dust and other destructive and wasteful materials now being emitted from stacks country-wide.

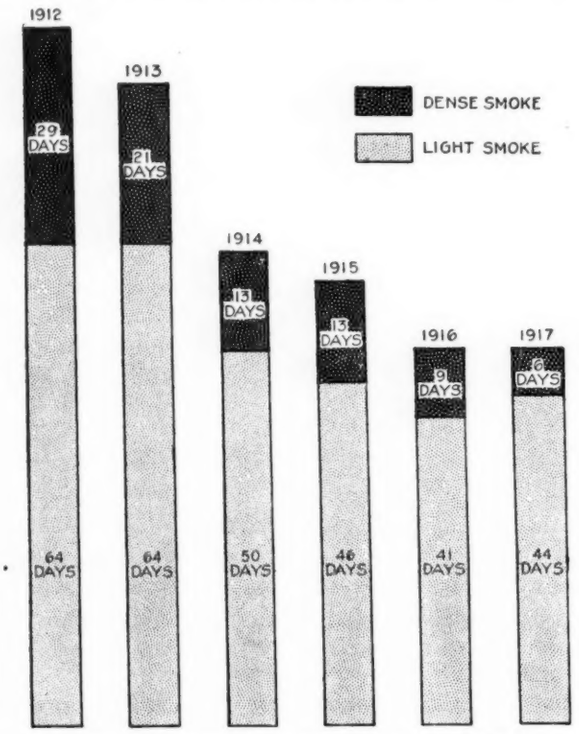
A mandate from the proper Government source having absolute power of control can cut the waste as indicated by "smoke" fully 50 per cent. almost immediately. This is a safe assertion because it merely requires personal attention with more frequent firing of small quantities of fuel to secure this result. Later, this dependence upon the man can be minimized by

mechanical means with still greater economies and an increase of output from furnaces and mills.

Laboring men and their organizations need not fear the displacement of labor by mechanical appliances; first, because the great war is causing a shortage of labor and, second, following the recommendations outlined in this paper will mean raising the standard of laboring men and training them along lines that will mean increased rates of wages.

Proof of these claims will be found in the experiences referred to later where specific cases are cited showing only partially what has been accomplished and what may be expected under the plan herein proposed.

Some of the more important things that can be done almost at the outset, to save fuel by mandate of the



SMOKE-ABATEMENT PROGRESS IN PITTSBURGH

Government in control of fuel consumption, are as follows:

a. Use bone coal in place of commercial bituminous and anthracite coals. This will be equivalent to increasing the visible coal supply by bringing into the market the millions of tons of bone coal piled nearly mountain high in the mining districts.

b. Use anthracite culm to replace commercial anthracite or bituminous coals. Remarks under (a) apply here.

c. Use coke breeze under boiler furnaces, thus applying what has heretofore been considered only fit for yard filling around manufacturing plants. A further saving of standard commercial coal.

Note: There are stokers now on the market and applied to furnaces efficiently burning these fuels.

d. Secure more complete combustion of all fuel, thus stopping waste in the processes of consumption.

Note: Examples are cited among the cases listed on another page.

e. Restrict the production of beehive coke, replacing it with byproduct coke.

f. Compel the application of waste-heat boilers to openhearth and other large furnaces.

g. Establish standards for fuel usage as outlined later.

h. Promote the development and use of substitutes for coal, coke and oil.

i. Maintain the gas supply for private residences where coal cannot be burned economically.

j. Increase the supply of fuel for internal-combustion engines. This may be accomplished as stated later.

k. Reduce the demand for artificial light by adoption of the daylight-saving plan, which has proven successful in Europe and as proposed to Congress by the Chamber of Commerce of the United States.

Results No. 2 and No. 3

Release men from nonproductive labor for productive effort, or increase the number of men available for war activities without interfering with production in the industries.

Hand-firing of furnaces is generally considered nonproductive labor. There are many cases where the application of mechanical devices for doing such work not only accomplishes fuel saving and increased output of better product, but does away with keeping men at such employment. These results will be further promoted by other labor-saving equipment such as installing ash-handling appliances in connection with furnaces now requiring several men for this work.

Instances are mentioned among the list of cases cited later in this paper. Most of them have been the result of an effort to comply with the laws regulating the production and emission of smoke from stacks. Under Government control of fuel consumption and of smoke regulation, the results can be multiplied almost immediately and continuously and kept up to whatever standard may be set by the Government.

4. Increase the Available Freight-Car Tonnage Without Adding to the Number of Cars

This will be brought about by reducing the quantity of coal required in the industries, for the same or greater output, and thereby relieve the railroads from the necessity of furnishing the equivalent tonnage for coal transportation.

A quotation on another page gives a concise statement of this phase of the problem.

5. Establish Standards for Fuel Usage According to Quality and Applicability

This heading carries its own argument. The country might be divided into fuel zones. Anthracite coal and natural gas should be saved to the people for use in the homes. Anthracite coal should not be permitted as fuel for boiler or other furnaces wherever other fuel, except natural gas, is available at the same cost or less, per unit of output. Such requirement might also be applied to the gas from byproduct coke ovens.

Low-volatile bituminous coals should be conserved for special uses where other bituminous coals cannot be used without excessive smoke, but where for other reasons, such as furnace construction, bituminous coals are the logical fuel. These include locomotives at terminals and in switching service, vertical and stationary boilers of the locomotive type.

It just happens that the experience with low-volatile bituminous coal in locomotive practice has been found more economical in the way of fuel saving for the same service, as compared with high-volatile bituminous coal.

6. Develop the Coal-Tar and Other Byproduct Industries

Here is opportunity for launching new industries which need fostering in this country. These industries are directly related not only to fuel saving, but also to all the results enumerated in the first part of this paper. If restrictions are placed upon the waste of coal in coke production, the industries incidental to the by-product-coke processes will be placed on a footing to compete with foreign countries.

The coal tar that will be recovered from byproduct coke making and wood distillation can be used as a substitute for coal, oil and gas, in many types of furnaces. A wide range of products may be produced by these processes, among which may be mentioned gas, paraffin, tar, resin, benzol, creosote, ammonium sulphate, alcohol, charcoal, pyroligneous acid, toluol.

As an example of how these products run into values in dollars and cents, figure on the possibilities in regard to gas from byproduct coke. Available statistics show coke produced during 1916, in the following amounts, in tons: Total coke, 51,544,447; beehive coke, 35,464,224; byproduct coke, 16,080,223. Allowing 8000 cu.ft. of gas per ton of coke produced, if the beehive coke had been made by the byproduct process, it would have amounted to 283,713,792,000 cu.ft. of gas. On the basis of one-half the heat value of natural gas, this is equivalent to 141,856,896,000 cu.ft. The commercial value figured on the consumers' rate (net) for natural gas in the United States is: 141,856,896,000 $\times$ 28.63c. per 1000 cu.ft. = $40,613,629.

Reference is made merely to the gas that might have been recovered should the quantity of beehive-oven coke have been made in byproduct ovens and without considering the gas that may have resulted from the coke produced in 1916 by this latter process. The 283,713,792,000 cu.ft. of byproduct oven gas as estimated according to its equivalent heat value in terms of natural gas, and based on the natural-gas consumption in the United States, would supply the demand for residence uses to the extent of 1,420,000 homes, satisfying the needs of about 10,000,000 people.

If it were used in melting steel by the openhearth process, the output from such furnaces would be in excess of 7,000,000 tons.

So much for the gas from the source indicated. The other products are of equal value in many ways. Incidental to the proposed discarding of beehive ovens is the elimination of smoke from such ovens and its ill-effects upon health and property.

7. Provide Gas To Replace the Natural-Gas Shortage

This is one of the incidental possibilities from coke making by the byproduct process. It should not necessarily follow that all the gas recovered in coke making shall be diverted to private-residence purposes, but this may be done where such use of it will be of more value to the country than when otherwise consumed.

If the total coke production for 1916, of 51,544,447 tons, had been from byproduct ovens, the gas that might have been recovered would have been equal in heat value to about 27½ per cent. of the total quantity of natural gas consumed in the United States that year.

Byproduct ovens can be operated primarily for gas production and at the same time give a soft coke comparatively high in volatile, suitable for private-residence furnaces, and produce the valuable chemicals already mentioned.

8. Add to the Supply of Fuel for Internal-Combustion Engines

Referring to the materials resulting from byproduct coke making, it is to be noted that benzol is among the number. As to the possibilities of accomplishing the purpose mentioned here, the reader is to note the following:

> Commercial alcohol and gasoline are not miscible. Alcohol and benzol are miscible and make a most efficient fuel, and further, after the addition of benzol to alcohol, the mixture will carry a high proportion of gasoline. The future may see benzol as the tie between gasoline and alcohol, permitting a piecing out of the gasoline supply and an introduction of alcohol as a commercial motor fuel.—*Journal of the American Society of Mechanical Engineers, June, 1917, p. 497.*

As smoke and its evil effects cannot be confined within political boundary lines set up by government, and as its prevention saves fuel and labor, improves products and increases output, and for other reasons which naturally follow, smoke regulation should be in the hands of the Federal Government.

In the following, Dr. Arthur A. Hamerschlag, director, Carnegie Institute of Technology, Pittsburgh, Penn., voices the opinion of many men:

> The Government has undertaken, for the benefit of the nation, to regulate and fix the price of fuel. It has also been interested in distribution, governing the car supply and determining the volume of fuel to be shipped to various centers. But it has neglected what is an equally essential element in fuel conservation, the consumption of fuel in efficient appliances. This has been left to the individual industry and consumer. It ought to be under the supervision and control of a centralized government agency, cooperating through state and municipal agents, that would compel the elimination of waste by demanding more efficient methods of securing heat from fuel.
>
> Until the Government recognizes this element of the situation, at least 25 per cent. more fuel will have to be produced at the mines than is needed in order to develop the energy required for the service of the nation.
>
> If we could increase the car supply 25 per cent., the labor supply 25 per cent., the output from the mines 25 per cent., or reduce the price of fuel to the consumer 25 per cent., we would consider that a great economic and patriotic movement was in progress.
>
> Since it seems impossible to increase in this ratio either the labor or car supply, why not attack the problem from the other end, accomplishing an equally satisfactory result?

This brings us to the "Cases" referred to several times in the preceding pages. What has been done in most of these instances has been brought about through pressure incident to enforcing the ordinances regulating the production and emission of smoke from stacks in cities.

From a Large Steel Corporation, Pittsburgh Plant: "To do away with the smoke evil, to save labor and make the fuel consumption more effective, we have endeavored to put into use such mechanical devices as will produce the best steam economies. Here we have scrapped an old plant of 55 boilers located on valuable land leased by your company for many years,

in which boilers the insurance companies would allow a pressure of but 85 lb. and have replaced them with eight 600-hp. units, having double the steam pressure of the old boilers, and with mechanical stokers. These eight boilers cost, with boiler house, coal- and ash-handling apparatus, including every mechanism known to produce an up-to-date plant, but $130,000. This new installation is saving $1500 per month in payroll and $3500 per month in coal, equal to $60,000 per annum, or 6 per cent. on $1,000,000. In addition, it has increased the capacity of the whole mill through a greater steam supply."

An Office Building in Pittsburgh: "In the winter of 1903 we installed four stokers under four 200-hp. boilers at a cost of between $4000 and $5000, including automatic control, air piping, blower engine and blower. Our average cost of upkeep to and including December, 1914, covering all repairs and replacements in connection with the stoking system, has been 2.79 per cent. on the original cost of installation. During the fiscal year preceding the installation of our stokers, our coal consumption was 171,010 bu., while in the year following, with the same steam requirements, it was 141,901 bu., a saving of 1106 tons, or 17 per cent."

A Bank Building in Pittsburgh: "We installed stokers, and the cost of coal and labor incident therewith was $6082.53. Assuming that we would have burned gas in that year, at the new rates the cost would have been $9254.25. Comparing these figures with those of the coal consumption, we have saved $3171.72, or practically more than the cost of the stokers."

An Independent Steel Company, Pittsburgh: "The boiler plant has 17 boiler furnaces. When stokers were applied to 9 boilers, they were producing as much power as they had been getting from the 17 boilers and replaced 23 men who had been used as firemen. This installation was made during the great demand on the plant for output and within a year beginning November, 1915."

A Manufacturing Company, Ohio: "After having stokers under three 150-hp. boilers for the past twenty months, I can issue the following information from practical experience: They have reduced our fuel bill 30 per cent. and a saving of $998 on labor for one year has been noticed."

A Manufacturing Company, Buffalo, N. Y.: "The four stokers installed have given the best of satisfaction, having done better than the guarantee. The saving in coal is equal to 16 per cent., and maintenance has been only an average of 0.01½ per cent. of the investment. The operation is very satisfactory, and boiler output can be controlled to the greatest possible economy."

A Tin-Plate Company, West Virginia: "The application of stokers to hot mill furnaces shows two things: First, that the coal consumption is reduced 20 per cent. to 25 per cent. and maybe more in some instances; second, because the air necessary to burn the coal is under control this gives absolute control of the flame and heat, which in turn enables the operator to heat his iron without scale. This, we find, is a great advantage to hot mill furnace work, and unless gas is obtainable at a very low price, the stoker-fired furnaces would be much more preferable. We have, in fact, installed in another of our plants stoker-fired furnaces to replace gas-fired."

A Foundry Company, Buffalo, N. Y.: This refers to a powdered-coal installation. "We have just completed dumping the castings in our No. 4 oven, and I have never seen iron in quality and uniformity to equal it. Every piece has been perfectly annealed, and they are 25 per cent. tougher than anything we have ever had from our other furnaces equipped with the old burners. The saving in coal will be around 30 per cent. Just as soon as we have run through two more ovens under favorable conditions, I will give you the exact figures showing number of pounds of coal per ton of castings."

The case mentioned as having experienced the greatest economies has not reached its maximum in this direction. Even this case is not as exceptional as some might imagine. All those shown herein indicate the possibilities for savings in the use of coal.

What the plants were doing previous to the changes leaves no doubt as to the necessity for taking action toward more efficient operation. Further economies in this direction, and in other ways as indicated in this paper, depend upon action by the Federal Government.

Van. H. Manning places the loss last year at $500,000,000, due to inefficient use of coal. Intimate acquaintance with plant operations, as a result of being connected with the Bureau of Smoke Regulation, Pittsburgh, Penn., makes it possible to testify that Mr. Manning's total figure is a conservative one.

The Working Plan Outlined

The machinery of government at hand is in the Fuel Administration and the Bureau of Mines. The foundation is already laid. It only remains for the Fuel Administration to broaden the scope of its activities and continue its existence and aims after peace shall be declared. The function of the Bureau of Mines should be to furnish information to be used as the basis for action on the part of the Fuel Administrator.

Example: The Fuel Administrator might desire data in regard to the practices and methods of a certain concern. Upon advice to this effect, the Bureau of Mines would make a thorough survey and report the results to the Fuel Administrator for such action as the conditions might warrant. For instance, if the concern should be using, say, 1000 tons of coal a day for a given production when a competitor is using but 750 tons per day for the same amount of output, the former may be compelled to take action leading to the efficiency of the latter.

It must be conceded that everything points to the plan proposed being feasible and practical and in line with a statement of the President in an address to Congress, Apr. 8, 1913, as follows: "We must . . . put our business men and producers under the stimulation of a constant necessity to be efficient, economical and enterprising, masters of competitive supremacy, better workers and merchants than any in the world."

Attention is called to an error in the article published on page 16 of the Jan. 1, 1918, issue of *Power* wherein the title should have read Tyler Condensation Meter instead of Taylor, and the manufacturer's name should have read Tyler Underground Heating System instead of Taylor, as published.—Editor.

Fires in Turbo-Generators

By M. A. WALKER

The possibilities of fires in large turbine-driven alternating-current generators are discussed and some of the possible means of combating these fires, should they happen to start, are suggested.

IN LARGE power-stations two goals are sought—one, economy of operation; the other, reliability of service. For large turbo-generators the former is accomplished by operating them at high load factors. Reliability is obtained by first-class construction methods and ample precautions. These generators are rarely if ever tied in to the station bus by automatic circuit-breakers, but instead must be disconnected by hand. Generator reactances, may, however, be installed to limit the current from or to the individual generators. Bus-tie reactances are likewise often employed for sectionalizing busses and limiting the energy transfer from one section to another. Many generators are controlled automatically, however, by means of balanced relays, so that the generator may be automatically disconnected from the station bus when it short-circuits internally, thus isolating the machine and preventing the flow of current from the station into the machine in trouble. This is a very necessary precaution because of the enormous magnetic stresses and heating involved, due to the current delivered into the defective machine from other units on the system. The modern turbo-generator may be capable of generating a current as high as twenty times normal on short-circuit and for the first few cycles.

Combustible Materials in Turbo-Generators

It is often stated that the modern turbo-generator contains nothing that will burn or support combustion. Practice refutes this, however. The cambric insulation impregnated with varnish makes an inflammable material, combustible in still air and quick-burning in an air current, such as the cooling air passing through the turbo-generator. The various tapes and cording on the end turns are likewise inflammable. The wooden wedges and spacers are also combustible, though some makers employ fiber wedges and spacers, a practice thought inadvisable since fiber warps and shrinks and absorbs moisture and oil. Other manufacturers employ wedges of brass, which is perhaps the best practice of all. Dust and dirt become embedded in the stator windings and likewise in the rotor, in an intensely dry condition, although portions are oil and grease soaked. It is possible that when an all-mica insulation is used, with noncombustible spacers and wedges and nothing to give off inflammable gas, the turbo-generator may be claimed to be fireproof. Even where air filters and washers are employed, as they are for the largest machines, dirt and dust gradually collect and make conditions favorable for fire.

The amount of air used by turbo-generators for cooling purposes depends on the efficiency of the machine. For a unit of about 25,000 kw. an average value would be about 2.5 cu.ft. per kilowatt, or a total of around 60,000 cu.ft. per minute. As the air ducts through the core and windings are restricted, this enormous quantity of air passes through the machine at a high velocity, probably between 5000 and 10,000 ft. per minute. If, now, a flame or arc starts, it is obvious that this high-velocity air fans the flame into an intense heat, burning very much like a blow-torch, which destroys everything within its reach—copper conductors, iron laminations and everything else. This high-velocity air thus causes not only more intense damage, but likewise more extensive, instead of somewhat localized as might be expected to be the case where the air is stagnant.

Most Favorable Place for a Fire

The most favorable place for a fire to start seems to be around the end of the winding and usually close to where the coils emerge from the slots. It is here that coil movement is most likely to occur, also the dielectric strains are the greatest and the accumulation of dust and dirt finds a ready resting place.

A fire started in varnish-impregnated cambric with a rapid supply of oxygen from the air may persist for an hour or more, although voltage and current no longer exist. Apart from the amount of combustible material, its combustibility is increased by the formation of gases from the impregnating compounds employed. The difficulties of fighting the fire are very real—it is out of sight and difficult to get at. Usually the casing of the generator has become so hot before help arrives that the covers cannot be touched for removal, while smoke and the noise from within do their part to interfere. In a severe fire the generator cannot be opened until the fire has burnt itself out and the outer casing has been cooled off with water. Perhaps this is really just as well, for combustion cannot exist without air, and it is probable that the fire extinguishes itself more rapidly by being inclosed than if the burning parts were thrown open to the air.

Extinguishing Fires in Turbo-Generators

As scientific methods are employed in the design, installation, operation and maintenance of a turbo-generator, it would seem that such might well be extended to fire fighting should the emergency arrive. Flooding the interior with water in a haphazard way will probably do more harm than good. To fight a fire scientifically in the present instance, it must be fought by methods thought of before the emergency happens and not by any or all methods that suggest themselves at the time. To the writer it appears, for the same reasons advanced in the article entitled "Transformer Fires," which appeared in the issue of *Power* of Sept. 18, that no effort should be made to open the cover of the generator. To do so permits the ingress of air and the escape of the gases of combustion, which, if confined, assist in extinguishing the fire.

To extinguish a fire rapidly, safely and with a minimum of damage the following precautions appear to warrant consideration: (1) When an internal short-circuit occurs in a generator, whether between phases or from one phase to ground, the automatic control should

disconnect the generator from the system and thus prevent the rush of current from the station bus into the fault. In addition to this—which is being done quite widely—the excitation of the generator should be killed simultaneously, by control from the same source as the main circuit-breakers. (2) Simultaneously with isolation of the defective generator the air supply should be shut off. The air inlet and outlets should have doors, normally open, but arranged to close by gravity, held open by a solenoid-controlled or motor-operated latch, in turn controlled by the balanced-relay protective circuit. Thus when an internal short-circuit occurs, which, as already pointed out, may be followed by a fire, not only would the generator be isolated from the system, but its voltage is killed and the supply of forced air for fanning the flame is cut off. The confinement of the gases of combustion within the machine will assist in extinguishing the fire. Should a fire start, there is less chance of its obtaining headway, while its effect should be local instead of distributed. (3) The shutting off of air is a radical and effective step toward preventing and limiting the fire. However, more heroic steps need be taken in quenching a fire once it starts. Therefore why not, as part of the installation, connect at two or more different locations of the generator casing inlets for fire-fighting fluid, so arranged that a fire in any portion of the windings can be reached? These inlets may be connected to water hydrants, storage tanks containing water, carbon tetrachloride or even carbon dioxide. The behavior and disadvantages of water are well known; it is, however, the most inexpensive. Carbon tetrachloride and carbon dioxide are both powerful fire extinguishers. They probably would smother a fire more rapidly than water, especially when used in the gaseous form. Carbon tetrachloride is an efficient solvent for rubber, which is, however, little used in modern generators, cambric and mica having taken its place. Tetrachloride is a rather rapid anæsthetic when admixed with air, while carbon dioxide is poisonous. Both these hazards should be borne in mind, although in stations where ventilation is good and the roofs high the danger is small. Where inlets are installed in the generator casing, the valves controlling them should not, as with the other safeguards, be automatic, since every short-circuit does not necessarily cause a fire, therefore does not require turning on the fire extinguisher.

Objections to the Different Methods

There are objections to all the foregoing suggestions: An automatically closing air inlet and outlet may close accidentally and thus cause overheating by interrupting the ventilation. Killing the excitation when the machine protective circuit operates accidentally, as it sometimes does for unexplained reasons, makes for delay in placing the machine back on the system. Every complication adds to the possibility of service interruptions. All precautions cost money, and in the present case are taken against a contingency that admittedly may never occur. Perhaps the cheapest precaution and the one that is least likely to cause trouble is that of installing inlets into the generator for water or other fire-extinguishing agency.

It must be realized that when turbo-generators of 70,000 kw. come into use, with boilers and auxiliaries, an integral part of the whole, taking one out of service means a big loss in capacity and also in the station's earnings, for the interest upon the investment still goes on.

No attempt has been made to cover the matter of generator fires fully in any one respect. Rather has effort been made to show that fires may occur; that the ventilating air adds much to the havoc wrought by the fire, and may even be the only means of permitting it to persist; and possible ways of extinguishing a fire as quickly as possible. What every operating engineer should realize is that a turbo-generator is not fireproof, that a fire may start and persist with great tenacity under the influence of the ventilating air drawn in by the machine as long as it revolves. Moreover, once fully started, a fire is rarely quenched until it has burned itself out, by which time the electrical end is practically destroyed. With the increasing use of turbo-generators and with increasing capacities, this subject is becoming of more and more importance. Experience is the best teacher, but it is preferable to gain experience of this sort second-hand. It is hoped, therefore, that this article in surveying conditions as the writer has found them may tempt others to enter the discussion and thus make available their ideas and the interchange of experiences.

Adjusting Marine-Engine Bearings

By William M. McRobert

One of the most important of the many duties of a marine engineer is the adjustment of the main engine bearings. To engineers who have operated on lake or river steamers it might be said that running an engine on the ocean is a little different from operating on inland waters, for it is the practice on fresh water to allow a stream of water to flow continuously on most of the bearings to avoid overheating and to reduce the amount of lubricating oil used. This cannot be done at sea, as the salt and other solid matter in the water would ruin the bearing in a short time, so that dependence is on oil alone.

When an engineer joins a ship with which he is unfamiliar, he should, in order to avoid trouble while on a voyage, examine and adjust all the main bearings and the crank and crosshead brasses. When proceeding to adjust a bearing and before taking off the nuts, they should be marked so that their respective positions may be known and the amount, if any, taken up in adjustment determined. To make the nuts readily distinguishable, they should be typed *P* for port and *S* for starboard, together with the number of the particular bearing to which they belong. The nuts on No. 1 bearing would therefore be designated as, *P*1 *S*1, for when looking toward the bow of the vessel the side to the left is known as port and to the right is starboard.

A simple and permanent method of marking the nuts so that mistakes in adjustments are practically eliminated is shown in Fig. 1. Prior to slackening back a nut, cut an arrow on the bolt with a thin, sharp chisel and make a light mark on the nut to coincide with it. Next remove the nut to the vise and graduate off somewhat as shown, using the mark already made for the zero or starting point. A piece of wood is necessary as

a center for the nut when laying off the graduations with a pair of compasses and a sharp flat chisel.

The arrow on the bolt will be used as the base from which all readings are taken, and a record of the posi-

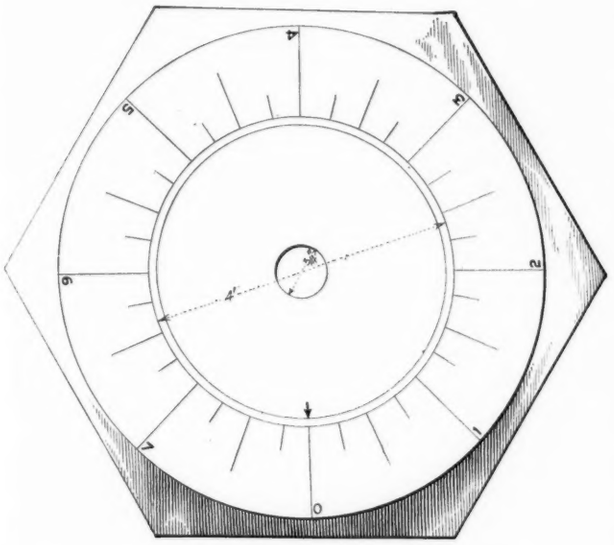


FIG. 1. NUT MARKED TO FACILITATE ADJUSTMENT

tion of each nut should be kept for reference in a manner similar to the following:

S. S..... At Port of..... Date.....

MAIN BEARINGS

	Port Nuts		Starboard Nuts	
No. 1	Before Adjustment 4⅛	After 4⅜	Before Adjustment 6¼	After 6½
No. 2	Before Adjustment 5	After 5¼	Before Adjustment 2½	After 3
No. 3	Before Adjustment 6	After 6¼	Before Adjustment 3½	After 4¼
No. 4	Before Adjustment 1¼	After 1½	Before Adjustment 5¼	After 5½
No. 5	Before Adjustment 3½	After 3¾	Before Adjustment 4¼	After 5
No. 6	Before Adjustment 2¼	After 2½	Before Adjustment 6½	After 7

All bearings including the crank bearings should have the same kind of record.

Having marked and removed the nuts from the bolts on one of the main bearings, for example, the engineer lifts the cap clear of the journal, by means of a chain or rope block, then lifts off the liners, noting down their number and description so as to replace them after cleaning thoroughly. In marine work soft lead wire is generally used to ascertain the clearance between the wearing surfaces. To do this, take two pieces of wire and place one, circumferentially, on each end of the journal within two or three inches of the ends of the bearing surface. On a large engine three "leads" should be used, the additional one at the center of the bearing. Care must be taken that the wire is a little shorter than the exposed part of the shaft or the ends will get on top of the liners when the cap is put on. Making sure the leads are in their proper positions (a little soap or grease will keep them in place), lower the bearing cap, put the nuts on and tighten them simultaneously until they are at their respective marks or perhaps a little past them, until the cap is "solid" on its liners. Notice particularly whether the cap is solidly down on the liners; if not, insert an extra liner to make it so. Again mark and slack off the nuts and lift the bearing cap and gage the leads for thickness and the uniformity to which they are squeezed out. Any desired adjustments may be made by removing or adding liners as occasion demands. Next comes the connecting-rod alignment and the adjustment of crank and crosshead bearings, referring to Fig. 2.

Every steamship engine is equipped with either a steam- or hand-operated turning engine for the purpose of setting the engine in any required position to effect repairs. Prior to moving the engine, take a look over the stern of the ship to see that there are no boats or ropes near the propeller, and also be sure that the engine itself is clear of obstructions; then by means of the turning engine put the high-pressure crank on the top center. On the face of the crosshead-shoe guide will be found two tapped holes, to which a piece of plate or a casting may be attached to support the piston and connecting-rod when the rod is disconnected from its crankpin. After this "guide plate," as it is called, is securely bolted in place, attach to each side of the crosshead a differential chain block. Mark the position of the crank-bolt nuts, as in the case of the main bearings, then slacken them back after screwing an eye-bolt firmly into the threaded holes in the ends of each of the connecting-rod bolts and pulling up slightly with the two chain blocks; next lower the bottom half of the bearing gently on both tackles until it rests in the crank pit. The eye-bolts and also the hooks on the chain block are small enough to pass through the bolt holes so the lower half can be lowered into the crank pit, or in case of small engines a rope sling may be used from the eye-bolt to the hook. A rope sling is sometimes used in place of the eyebolts to support the chain blocks at the crosshead. With the turning engine, turn the crank slightly ahead until the crankpin is just clear

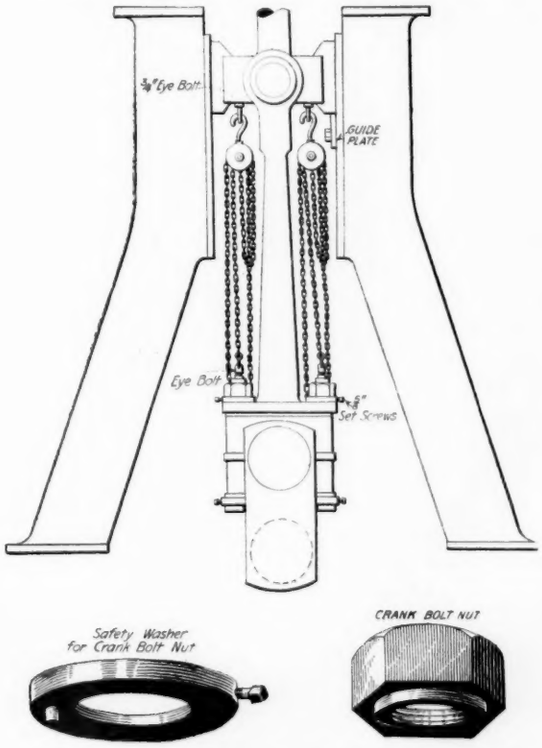


FIG. 2. UNSHIPPING A CRANKPIN BEARING

of the top half of the bearing, first making sure that the latter is held in place with a capscrew passed through each of the flanges. Keep the bearing off the crankpin, and with a pair of inside calipers measure to see if the end of the connecting-rod is hanging central between the webs of the crank. In order to obtain smooth running, this condition must be realized.

Should the connecting-rod be out of alignment, it may be corrected by inserting a thin liner between the lower crosshead brass and the top end of the connecting-rod. Pounding might be overcome in many engines if the rods were put in line. It is sometimes necessary to scrape the babbitt metal of the bearings in order to get a true alignment, but no matter what is called for, the engineer can rest assured that continual trouble will ensue as long as the conneting-rod is out of alignment.

On a 12,000-hp. quadruple-expansion engine the writer sailed with, he spent many a hard day in tropical climates scraping the bearings to put the high-pressure rod in line; in fact, on every available opportunity the chief had him on this job, but eventually success and comfort were the reward.

If the rod is found to be in line, turn the engine back until the crank is on its exact top center and take off the guide plate and remove the cap bolts from the top half of the connecting-rod bearing, then raise the lower bearing out of the crank pit until the bolts have just entered the holes, then carefully place two or three pieces of lead wire circumferentially at equal intervals along the surface as described for the main bearing, then pull the bearing or cap up into position and tighten the nuts to their previously located marks. Again slacken back the nuts and lower the bottom half of the bearing just so the leads can be removed. If they are the right thickness, clean the bearing thoroughly and pour a little clean oil on the surface, then heave up and pull the nuts solidly up to their marks, using a hammer on the wrench and being certain as before that the bearing is up solid on the liners. The intermediate-pressure and low-pressure engines are adjusted in turn in the same manner as described.

The foregoing is intended as a mere outline on the subject of the adjustment of marine-engine bearings, all of which is familiar to seagoing engineers, but there are three important points to be remembered, which should be emphasized; namely, before turning the engine, see that the propeller is clear, that the guide plate is off and that all other obstructions are removed.

Morris Improved Tube Beader

To properly expand and bead a boiler tube requires considerable experience and expertness when the common expander and beading tool are employed. An inexperienced workman is more than likely to thin the tube end by excessive rolling, as in Fig. 1, thus reducing its strength where it is needed. In beading the

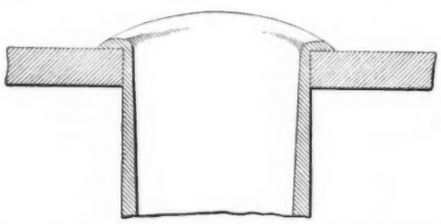


FIG. 1. RESULT OF EXCESSIVE ROLLING

tube ends by the hand tool they may be bulged, as shown in Fig. 2, thus forming a pocket between the tube and the tube head, which would increase the possibility of the tube burning out at that point.

A machine that has been designed to strike a blow on the beading tool at the right position and to expand and bead a boiler tube at one operation, at the same time eliminating the defective resuits shown in Figs. 1 and 2, has been developed by the Wallace Manufacturing Co., 1319 West 42nd St., Kansas City, Mo. This device, Fig. 3, known as the Morris beading tool, con-

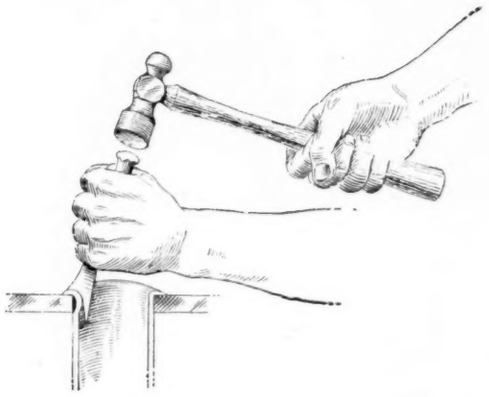


FIG. 2. BULGED TUBE IN TUBE SHEET

sists of a lever-operated 6-lb. hammer *A*, the striking blow of which is governed by the propelling springs *B*, the strength of which is adjustable by the bolt *C*.

A beading tool *D*, which beads and expands a tube in one operation, is at one end of the frame holding the hammer. It is rotated in the tube by a ratchet movement *E* actuated by the hand lever *F* which operates a camwheel *G* which is rotated by the two pawls *H* to lift the hammer and trip it into action. The tool is held in place at a boiler head by an adjustable supporting block *I* containing wedge bolts, which are expanded after the supporting block is placed in a tube,

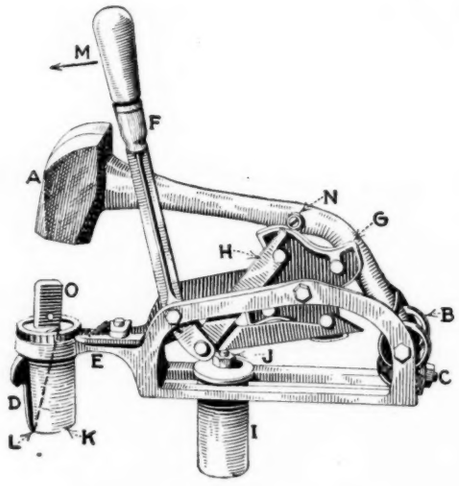


FIG. 3. MORRIS TUBE BEADER

by the bolt *J*. A head block *K* holds and guides the beading tool in place, and the dotted line *L* shows the angle the tool is driven on for expansion of the tube.

The application and operation of the tool are simple and it can as easily be worked at one part of the tube sheet as at another. When about to use, the head block of the beading tool is placed in the tube to be secured in the tube sheet. the supporting block being placed in

any other tube already in place, within the scope of the tool. With the tool in place the operator pulls or pushes the lever in the direction of the arrow *M*. This movement rotates the camwheel *G* to the right, and as the roller *N* reaches the edge of the camwheel, the weight of the hammer *A* and the tension of the springs

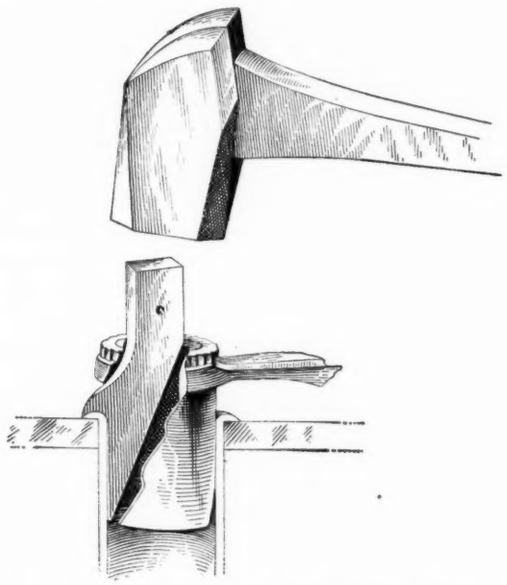


FIG. 4. HOW THE BEADER FITS IN THE TUBE

B produce a sharp blow on the head block *O*. Each time the lever is operated for a hammer stroke, the ratchet is rotated two notches. Fig. 4 shows how the beader enters a tube and also the kind of joint it produces between the tube and the head, there being no thinning of the tube end or forming of a pocket between the tube and the head.

Calculating the Contents of Oil Tanks

BY R. T. STROHM

The increasing use of liquid fuels has brought about the storage of large quantities of oil, gasoline and similar products. The usual type of storage tank is a cylindrical steel shell with bumped heads, placed in a horizontal position and ordinarily buried in the earth as a matter of safety. The calculation of the amount of oil in a tank of this kind, when the oil stands at a certain level, is a problem that seems to cause operating engineers considerable difficulty, largely because of the use of bumped heads. If the heads were flat, the problem would be greatly simplified.

The depth of the oil is commonly measured in inches above the bottom of the tank, this distance being determined by a measuring rod inserted through the manhole or by some form of registering gage. The known data, therefore, are the length and diameter of the cylindrical part of the tank, the radius of curvature of the heads, and the depth of oil in the tank, and from these the quantity of oil must be calculated.

Since the amount of oil on hand at any given time is information that must be quickly available whenever it is called for, the best thing the engineer can do is to make up a table showing the cubic contents of the tank for every inch of depth. Then, by measuring the depth of oil, he can quickly refer to the table and so determine the quantity of oil on hand.

If a reliable meter is available, the quickest way to compile the table is to use the arrangement shown in Fig. 1. Connect the meter *a* to the filling pipe *b* and have a shutoff cock *c* in the oil-supply pipe *d*. Insert a measuring rod *e*, graduated in inches from the bottom end, through the open manhole. Then run oil into the tank until the measuring rod shows a depth of one inch, and read the meter. The quantity of oil run in will be the quantity corresponding to a depth of one inch. Mark this down in the table, run in oil until the depth is two inches as indicated by the rod *e*, and read the meter again. If the meter is set at zero at the start, the second reading will be the quantity of oil at a depth of two inches, and so on for each additional inch.

If no meter is available and no similar method of measuring the quantity of oil run in for each inch of depth can be used conveniently, the table may be compiled by a series of calculations that are not difficult to make, though they are numerous and therefore apt to be tedious.

Assume, for example, that the tank in question is 28 ft. long and 8 ft. in diameter and that the ends are parts of spherical surfaces, with a rise of 10 in. at the center line of the shell. Make a scale drawing of the tank, as shown in Fig. 2, using as large a scale as possible, to obtain accuracy. On the center line *ab* find by trial a center *c* for a circle that will pass through

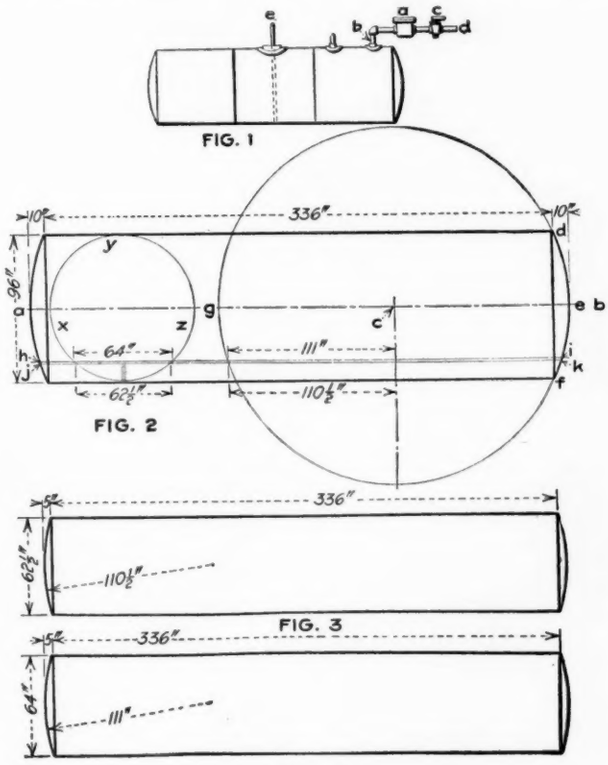


FIG. 4

METHODS OF OBTAINING MEASUREMENTS

the points *d*, *e* and *f*, and draw the circle *defg*, which will represent the sphere of which the bumped head is a part. The small circle *xyz* is a cross-section of the cylindrical shell.

Beginning at the bottom of the shell, draw lines parallel to the axis *ab* and one inch apart. These will divide the entire tank into 96 layers, each one inch thick, and the problem then resolves itself into finding the cubic contents of each layer. To illustrate the method to be followed, let the layer between the twelfth and thirteenth inches be taken.

First, draw two lines *hi* and *jk* at these two points. The lower surface of the layer will then have the shape and dimensions shown in Fig. 3 and the upper surface the shape and dimensions shown in Fig. 4. The sizes of both these sections are obtained directly from Fig. 2, as may be seen from the corresponding dimensions. As both sections are drawn to scale, the rise of the segmental end can be scaled. It will be found to be practically 5 in. in each case.

The area of the section in Fig. 3 consists of a rectangle $62\frac{1}{2}$ x 336 in. and two segments whose diameter is $2 \times 110\frac{1}{2}$ in. and whose rise is 5 in. The area of a segment is found by the formula,

$$A = \tfrac{1}{3}H^2\sqrt{\frac{D}{H} - 0.608}$$

in which A is the area in square inches, H the height of the segment in inches and D the diameter of the circle of which the segment is a part. In this particular case

$$A = \tfrac{1}{3} \times 25\sqrt{\frac{221}{5} - 0.608} = 220\ sq.in.$$

and the area of both segments is 440 sq.in. The rectangular part has an area of $336 \times 62\frac{1}{2} = 21{,}000$ sq.in. and so the total area of the section is 21,440 square inches.

By a similar procedure, the area of the segmental end in Fig. 4 is found to be 220 sq.in.—the difference between this and the end in Fig. 3 is so slight as to make no appreciable change in the area. The total area of the section in Fig. 4 is therefore $336 \times 64 + 440 = 21{,}944$ sq.in. Now, with sufficient accuracy for all practical purposes, the volume of the layer between *hi* and *jk*, Fig. 2, may be taken as the average of the areas of the upper and lower faces multiplied by the thickness of the layer, which is one inch; hence, the volume of the layer is $\frac{1}{2}(21{,}440 + 21{,}944) \times 1 = 21{,}692$ cu.in., or about 94 gallons.

The volume of each layer from the bottom to the center line should be calculated in this way. Since the layers between the center line and the top are of exactly the same size and shape as those between the bottom and the center line, but in the reverse order, the calculations will need to be made for only 48 different layers.

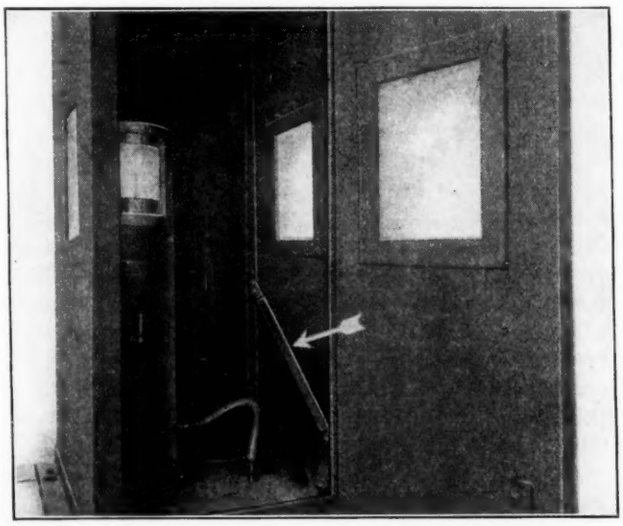
In calculating the volume of the first layer at the bottom—which is the same as the first one at the top—the area of one surface is zero; hence, the average area of the two faces of the layer is simply half of the area of the one surface whose area is calculated.

In making these calculations, extreme accuracy is a waste of time. If the areas are determined to the nearest ten square inches, the table will be quite accurate enough, for the diameter of the tank is not the same throughout because of overlapping plates and the graduated measuring rod cannot be read to small fractions of an inch. If the table values are worked out to the nearest five gallons, they will meet all ordinary demands.

It should be noted that the volume added by the bumped heads is 440 cu.in., while the total volume included by the layer is 21,692 cu.in. Thus the bumped heads contain $440 \div 21{,}692 = 0.02$, or practically 2 per cent. of the total volume; in other words, if the heads were neglected altogether and considered to be flat, the error would be only 2 per cent. at the section shown in Fig. 2. At the level of the center line of the tank, where the head has its greatest projection, the error is still within 4 per cent. of the total volume.

Steel-Jacketed Electric Heater

The steel-jacketed electric heater unit indicated by the arrow in the figure has been put to innumerable uses in all kinds of industrial plants. Besides such applications as in crane cabs, valve, pump and meter houses, there have been scores of miscellaneous applications. The ease of conducting electric current to remote corners, to moving-crane cabs, etc., makes the use of electric heaters simpler than any other. The heater unit shown is of 500-watt capacity, can be connected in multiple to any alternating- or direct-current circuit where the voltage is not in excess of 250. Only as many as are actually required need be installed, and additions made when required as easily as adding electric lamps. Just as lamps are placed singly or in groups in locations where light is needed, so also are these units mounted singly or in groups in places where heat is required.



HEATER INSTALLED IN GAS-VALVE HOUSE

The units are flat like an ordinary meter, the dimensions being $\frac{3}{16}$ x $1\frac{1}{2}$ x $23\frac{3}{4}$ in. All parts are inclosed, and no porcelain, cement, asbestos or molded insulation material used. The installation in the figure shows one of these units installed in a gas-valve house. These heaters are designed and manufactured by the Cutler-Hammer Manufacturing Co., Milwaukee, Wisconsin.

In offering "War-Savings Stamps" to the public the Government has made immediately available for every man, woman and child in the country a profitable, simple, and secure investment.

Editorials

Developing the Water Power

THE agitation for the development of the water powers has culminated in the submission to the President by the Secretaries of War, Interior and Agriculture, jointly, the draft of a proposed bill which embodies the fundamental principles of several bills now pending in Congress and seeks to avoid or cure their defects. The letter of transmittal, which will be found on page 135, outlines its principal features. A commission composed of the Secretary of War, the Secretary of the Interior and the Secretary of Agriculture, and having an executive officer who shall be appointed by the President, is to make investigations and to collect and record data concerning the power industry and its relation to other industries, and concerning the location, capacity, development, cost and relation to markets of power sites; to make public from time to time such portions of the information secured as it shall deem expedient in the public interest, and to issue licenses to citizens of the United States, or to any association of such citizens, or to any corporation, state or municipality, for the purpose of constructing, operating and maintaining dams, water conduits, reservoirs, power houses, transmission lines or other project work necessary or convenient for the development and improvement of navigation and for the development, transmission and utilization of power. The licenses are to be granted for definite periods not exceeding fifty years, and are irrevocable inside of that period, except for cause. Upon or after the expiration of the lease the United States shall have the right, upon not less than two years' notice, to take over any project covered in whole or in part by the license, upon paying a fair value, not to exceed the actual cost of the property taken, plus such reasonable severance damages, if any, as may be caused by the separation of said property from property valuable, serviceable and dependent not taken.

It would seem that under such a provision the Government would be powerless to exercise the right of eminent domain, no matter how badly the property might be needed, within the term of the lease, although there is provision that the Government may commandeer the plant temporarily in case the safety of the United States demands, for the purpose of manufacturing nitrates, explosives or munitions of war, or for any other purpose involving the safety of the United States, paying to the party, or parties, entitled thereto such just and fair compensation for the use of the property as may be fixed by the commission, on the basis of a reasonable profit in time of peace. It is not clear who shall exercise the right of recapture at the end of license period, on behalf of the United States, or who shall question or decide whether such recapture is advisable.

Inasmuch as the fifty-year license is insisted upon, in order that the licensee may get back his investment within the term of the license, it is not fair that the Government, at the time of recapture, should be expected to pay anything like the full cost of the project. A "fair value" is an indefinite and indeterminable quantity. It would be much preferable to retain the right to recapture at any time upon the restitution to the licensee of all that had been expended upon the property, less what had been retired in depreciation and discharged indebtedness.

The regulation of the issue of securities, the control of expenditures, and the fixing of rates, are left altogether to the public utilities commissions of such states as have such bodies, the newly created commission having the right to exercise these functions in states where no such bodies exist, but being obliged to surrender them to such bodies when created. We should have preferred to see such control unified and systematized in the Federal Commission, and to see, as one of the terms of the license, that the price of current should be fixed at cost plus a fair and stipulated profit. The commission may, in its discretion, give preference to applications for licenses by states and municipalities for developing power "for state and municipal purposes," but apparently not for the general use of its inhabitants.

An annual rental of not less than ten cents per horsepower is to be charged. Fifty per cent. of the charges arising from licenses for the occupancy and use of national forests is to be expended in the survey, construction and maintenance of roads and trails within such national forests. Fifty per cent. of the charges arising from licenses for the occupancy and use of public lands, national parks, national monuments and power sites reserved outside of national forests shall be paid into the Reclamation Fund. All proceeds from any Indian reservation shall be placed to the credit of the Indians on such reservations, and fifty per cent. of the charges arising from all other licenses is reserved as a special fund to be expended in the maintenance and operation of dams and other navigation structures owned by the United States, or in the construction, maintenance or operation of headwater improvements on navigable rivers of the United States. This rental will, of course, be an item in the rate-fixing charges and the users of the current will thus be taxed for the purposes named.

The licensee is required to furnish, free of cost to the United States, power for the operation of navigation facilities connected with the project, whether constructed by the licensee or by the United States. The licensee must commence the construction of the project work within the time fixed in the license, thereafter in good faith and with due diligence prosecute such construction and, within the time fixed in the license, complete and put into operation such part of the ultimate development as the commission shall deem necessary to supply the reasonable needs of the then available market. Should he fail to do so, the Attorney General, upon the request of the commission, shall institute proceedings in the District Court of the United States for the district in which any part of the project is situated, for the revocation of such license, the sale of the

works constructed and such other equitable relief as the case may demand.

The time to fix definite terms is when one is making a bargain. The terms of the proposed license do not enable one to judge with sufficient accuracy how the price of the service rendered by the licensee is likely to compare with what it would cost if rendered by the Government itself.

The first step toward the passage of the foregoing bill was taken by the House of Representatives on January eleventh, by the adoption of a resolution providing for the appointment of a special committee of eighteen members to which shall be referred all bills and resolutions introduced during the Sixty-fifth Congress (except those touching foreign affairs), which deal with water-power matters. The committee, which will be named by the Speaker, will serve only during the present Congress.

The adoption of this resolution discharges the committee on Interstate and Foreign Commerce and the committee on Public Lands from further consideration of the various bills that have been before the House for some years, and these bills are to go to the new committee. The proposed legislation in regard to water power at Niagara Falls is left in the hands of the House Committee on Foreign Affairs.

A bill introduced in the House on January ninth is intended to give the President power to take posession and assume control of any water-power projects using the waters of Niagara River for manufacturing purposes. The bill further empowers the President to retain possession, management and control of these projects for such time as may appear necessary to him during the period of the war, and then to restore them to their original owners, who are to be paid a fair and just compensation for the use of their property, as determined by an impartial agency. The basis of this compensation is a reasonable profit in times of peace, to which must be added the cost of restoring the property to as good condition as existed at the time it was taken over, less the value of improvements made thereto by the United States during its tenure.

In connection with the question of Government control of water powers, it is significant to note that Governor Whitman, of New York, in his message to the Legislature, advocated the idea that the state should undertake to develop some of its unused water power, a large amount of which has been created by the construction of the new barge canal. After developing the projects, the state might either operate them itself or lease the plants to others.

The present activity in regard to water-power utilization indicates an acute appreciation of the urgent need of tapping sources of power as yet untouched, to relieve the pressure on the fuel industries and the transportation systems; and under the spur of necessity it is probable that the long delay will be succeeded by prompt, equitable and conclusive action.

Coal

COAL continues to be the principal concern of the power-plant owner and engineer. To the extra quantity required to meet the normal growth of the country has been added that required by the speeding up of industry and the increased activity of the railroads. Even if the mines could produce the additional quantity needed, the railroads cannot transport it, and the demand, the difficulty of transportation and the suffering due to the lack of fuel have been enhanced by unusually long periods of exceptionally cold weather.

Industries have been shut down, hotels and hospitals and homes without coal, street-car lines stopped, public utilities hampered, commutation service deranged, and all the habits and activities of the people overset because of the shortage of fuel.

All this has resulted in a wild scramble for coal, not only on the part of individuals, but of localities. Local officials and administrators have commandeered coal passing through their territories en route to other sections. New England and New York are contesting for priority. There is not coal enough for all. Some must get along without—but who?

Obviously, provision must first be made for the absolute essentials. Homes, hospitals, hotels and places where people are obliged to work must be kept warm, the people must be transported to and from their work, food must be prepared, distributed and cooked. There are many things for which coal is burned that might be spared temporarily, and there has been much talk of cutting off the fuel supply to nonessential industries, but this would throw thousands out of employment and be productive of widespread suffering.

The United States Fuel Administration made public on January eighth its "budget plan" of allotting the available coal supply.

Committees representing the large industries not engaged in war work—more than one hundred in all—will be called into conference with the officials of the Fuel Administration. They will be shown the amount of coal available for all purposes, the amount required for war purposes and domestic consumers and the total curtailment of the use of coal which must be effected to satisfy these demands.

They will be asked on patriotic grounds as well as for their own future interests to volunteer in behalf of their industry a reduction of the coal consumption for the year 1918. They will be asked to show the Fuel Administration the best method of accomplishing this curtailment. They will also be asked to advise the Fuel Administration as to how to arrange these restrictions so as to affect only the less essential portions of their own business if possible.

When an agreement is thus reached as to the quantity of coal to be conserved in each industry, the Fuel Administration order will be issued, making this agreement effective as regards the total industry involved.

The voluntary annual saving shown by the first dozen industries called into conference promises to be between fifteen and twenty million tons. The total offering, from all nonwar industries will be between thirty-six and fifty million tons for the year 1918.

Fuel needed in 1918 for Army and Navy purposes, for munition works, for public utilities, for domestic consumers, and for factories working on war material is scheduled in the budget for one hundred per cent. fulfillment. With this figure and the estimated production of coal during 1918 as a basis, a subtraction shows the amount of fuel left for nonwar industries.

All the large American industries which have so far met with the Fuel Administration have shown a willingness to go voluntarily just as far as necessary in curtailing their activity. The Fuel Administration asks

that other industries affected get in touch with Washington without waiting for formal notice.

In the meantime the situation has become so acute that Fuel Administrator Garfield has ordered all manufacturing plants to shut down immediately for five days, and thereafter on every Monday up to and including March twenty-fifth. Certain exceptions are made in favor of plants that must be operated continuously seven days a week, those engaged in manufacturing perishable foods, and printers and publishers of papers and periodicals; also, fuel may be burned on Mondays to prevent damage to property from freezing. The situation will continue acute until a sufficient spell of moderate weather uncripples transportation, and the congestion which hampers the movement of freight can be relieved. All that the individual can do is to put up good-naturedly with disarranged service, and save, *save*, SAVE. Save fuel directly in every possible way—save it by burning fewer lights, by heating fewer rooms; save it indirectly and lessen the burden upon the transportation facilities by traveling as little as possible and buying nothing that you can get along without; for there is nothing that does not require coal and transportation in its production and delivery to you.

The Joliet Plant

ON OTHER pages of this issue is a description of the new Joliet plant of the Public Service Company of northern Illinois. Among stationary plants in this country it is one of the first to reach an operating steam temperature of six hundred and fifty degrees. At the Buffalo General Electric plant recently placed in operation the steam temperature is six hundred and eighty-nine degrees, obtained from a steam pressure of two hundred and seventy-five degrees. In the present case the superheat is less by fifty degrees but the pressure is greater, being three hundred pounds at the turbine and enough higher at the boiler to insure the above density. It is probable that the boiler pressure will approximate three hundred and twenty-five pounds, the design still allowing an additional twenty-five pounds.

There appears to be some difference of opinion as to the choice of pressure or superheat in making up the total steam temperature. Theoretically, the advantage is on the side of higher pressures, but here mechanical difficulties place restrictions. To obtain a temperature range such as exists in the plant under discussion, a compromise is necessary. Pressure up to the present mechanical limits is employed and then superheat to increase the initial temperature and add to the efficiency. Other factors influencing the degree of superheat are steam density and condensation during expansion. Superheat reduces the density and lessens friction. It also tends to prevent liquefaction in the turbine and should increase with the pressure. It is evident, then, that pressure and superheat must go hand in hand, the ratio to be determined by existing conditions and the results obtained from practice.

While little trouble is expected in the turbine, as up to a certain point it is merely a case of using heavier construction at the first stage and perhaps additional stages to cover the wider range, it is different with boilers and fittings. At Joliet the limit in pressure has been reached for the standard design of large boiler. Experimental work is being conducted to develop boilers for the higher pressures, but some time must naturally elapse before any new design is ready for practical application.

While the arrangement of boiler and economizer at Joliet has been used for several years in some of the leading stations in Europe, it is new to this country, as is the use of the all-steel horizontal economizer. To withstand the high pressure, steel is more reliable than cast iron, but it is more subject to corrosion from low-temperature flue gases. Galvanizing the tubes should neutralize this action.

The design of the unit calls for height in the building, but not so much as for the individual detached vertical-tube economizer placed in the same location. The above-ground basement is another factor adding to the height, but this is counterbalanced to some extent by small overhead bunker capacity calling for no additional height and minimizing the steel requirements. One great advantage of this arrangement is the elimination of ash-handling equipment. Another feature is the economical use of floor space. With backs retreating to the rear of the bridge-wall, the boilers require less than three-tenths square foot per nominal horsepower based on ten square feet of heating surface. The figure given omits the overhang at the rear.

No comprehensive tests have been conducted at the plant, so that the increase in efficiency over average present practice is open only to estimate. Owing to the favorable conditions it is quite probable that the over-all boiler efficiency may exceed eighty per cent., a gain of, say, five per cent. over good average practice. Theoretically, the one hundred pounds pressure additional to that commonly employed in the larger plants makes possible a gain of between six and seven per cent. in the turbine, giving a steam consumption that will compare favorably with the best from the largest units. It would not be unreasonable to expect a net production of one kilowatt-hour on eighteen to nineteen thousand British thermal units.

Against this increase in economy must be charged the additional investment. It has been estimated that boilers for this high pressure cost about twenty per cent. more than those designed for pressures close to two hundred pounds. The piping, valves and fittings are also more expensive, but small diameters help limit the cost. An analysis of actual figures should show a net advantage to the plant well worth while.

An appeal has been made by the Machine Tool Section of the War Industries Board, Council of National Defense, to the machine-building industry to relinquish a large number of heavy machine tools which are urgently and immediately needed for making heavy guns. There is no time to have them built. They must be taken from shops that already have them in use. To their owners is given the opportunity of doing something for the service of mankind—something that will save thousands of lives and prevent hundreds from being crippled. In modern warfare big guns are a paramount necessity. Without heavy artillery to clear the way, the loss of life in assaulting columns runs up to forty and sixty per cent. With adequate artillery preparation the loss is reduced to three to five per cent. The sacrifice asked is small compared with that of the thousands of boys over there who are making the supreme sacrifice—all they've got.

Correspondence

High Speed of Steam Turbines

In the Oct. 2 issue of *Power* W. F. Shaphorst discusses the subject of high speed of steam turbines. I have also noticed C. H. Watson's comments on the same subject in the issue of Nov. 6.

Mr. Watson points out that an 80 per cent. overspeed test will be highly objectionable from the designer's point of view. In this he is, of course, entirely correct. For a given power not only would a more expensive and a less efficient machine result, but turbines of as high power rating as are now manufactured could hardly be produced with any materials available at the present time.

Neither of the writers, however, seems to have considered that an 80 per cent. overspeed test, in the majority of cases, would be far from conclusive evidence that the various parts would be able to withstand the stresses occasioned by such overspeed as the turbine may be put to as a result of the failure of its safety appliances to perform their functions. I believe it can safely be said that 75 per cent. of all the turbines manufactured in the United States today, if unleashed from the reins of their speed regulators and unloaded, would assume a speed in excess of 180 per cent. of the operating speed.

As is commonly known, the speed that a certain turbine will assume under these conditions depends upon several factors. The main factor is the relation between the steam and blade velocities. In the Rateau turbine this relation is, for the best efficiencies, commonly taken as 2.3, while the theoretical figure for small nozzle angles is 2. If the windage losses in the turbine were entirely neglected and the theoretical figure used, when the blade velocity had increased to such an extent as to equal the steam velocity there would no longer be a force component in the direction of rotation, and consequently the speed of the turbine would be twice the normal operating speed.

Using the practical figure of 2.3 and still neglecting the windage losses, the overspeed to which the turbine would be theoretically put would be 130 per cent. However, if the turbine has a low horsepower rating, the windage losses for this overspeed will amount to so much that the machine will be self-loading before it reaches this point. It is true that the steam would impinge on the back of the blades long before this point was reached, but the blade losses as a result of this would be only about twice as great as if the angle of entrance into the blade row were the same number of degrees smaller than the blade-inlet angle, as it is greater in the present instance.

Furthermore, a well-designed Rateau turbine has a bucket-entrance angle sufficiently wide to take care of a steam velocity corresponding, approximately, to 70 per cent. load, rather than full load, without shock on the back of the blades. For a Curtis turbine with two rows of moving blades, the ratio between steam velocity and blade velocity would be about 4.5, practically, and as a consequence, the theoretical speed at which a turbine of this kind would be self-loading would be 350 per cent. above normal. The Parsons turbine would theoretically become self-loading at 100 per cent. overspeed. Here, as well as for the straight Rateau turbine, it is true that windage and blade losses would make the turbines of ideal condition self-loading long before reaching the theoretical point.

While the foregoing figures are those for the ideal conditions, a very small percentage of turbines are manufactured, in which such relations between steam and blade velocities actually exist. The figures are almost always greater. The reason for this, as is easily understood, is the fact that the frames required to make turbines commercial for small capacities will ordinarily be smaller than the frames at which they would give their best steam rate.

While high speed for steam turbines of larger type is a relatively new practice, as Mr. Shaphorst points out, in the field of small turbines, on the contrary, the last decade has shown a falling off in popularity of extremely high speeds. Instead of using single-stage units of 30,000 to 40,000 r.p.m., we are now generally employing 5000- to 7000-r.p.m. geared machines, and from 1000- to 4000-r.p.m. direct-connected.

There is no reason why a well-designed and intelligently operated high-speed turbine should not be as safe as a lower-speed machine. In some instances the drive is of such a nature as to render unnecessary any governor or overspeed device. For instance, in case of a blower or fan the additional resistance experienced for overspeeds is so great as to keep the unit from increasing its speed unless the runner on the fan should break for some reason or other. It would, therefore, generally be safe to leave off all governor mechanisms for a blower unit.

With the centrifugal pump it is generally considered allowable to leave off the governor and run the turbine with an emergency governor alone. This is also true of turbines used for ship propulsion.

For a generator unit, as Mr. Watson points out, there are always supplied the main governor and an emergency trip governor, these two safety devices being entirely independent of each other. The main governor is sometimes operating the steam-admission valve directly through a lever or a linkage, and in some instances the valve is handled by oil or steam pressure, regulated by a pilot actuated by the governor. The design of linkage and pilot-valve arrangement offers opportunities to guard against accidents. For instance, if any part of a properly designed governor mechanism should break, the valve should always close. If the pilot spindle should unscrew or be broken off, its motion should always be such as to admit oil or steam on the side of the operating piston, which would make the valve close. Further-

more, a spring or a small steam cylinder should be arranged over the valve so that in case the oil pressure failed the turbine would shut down. On low-pressure turbines, operated at, say, 2 lb. back pressure and 28 in. vacuum, it is generally considered good practice to install a vacuum breaker actuated by an emergency governor, in addition to the trip valve in the inlet of the turbine. In fact, the trip valve is often left off entirely and the vacuum breaker depended on to keep the turbine from running away, and this is generally safe.

In high-speed turbines there are certain characteristics that may give rise to trouble if design is not properly made. The one most commonly talked of is the flexibility of the shaft. As Mr. Watson says, impulse-type turbines are generally made to run somewhat above their first critical speed. This is also, I believe, a good practice. A turbine rotor will generally run with less vibration after it has gone through its first critical speed than before this point has been passed. This is a fact commonly known and recognized by all turbine builders, and contrary to Mr. Watson's supposition, the larger of the reaction turbines for land work also have flexible spindles and run through their first critical speed before coming up to operating speed. For marine turbines this condition is, of course, not allowable, since a marine turbine will be called upon to operate at any speed below its maximum running speed.

A turbine of any kind can generally be made to operate the best between the first and second critical speeds, but if the shaft is so flexible that the turbine is allowed to pass through the second critical speed before reaching the operating speed, if these critical speeds do not come more than 3000 r.p.m. apart, and unless the turbine is in perfect balance, it is often difficult to obtain smooth running at operating speed.

The bearings for high-speed turbines have occasioned a certain amount of difficulty in the past, when the theory regarding the proper way of admitting the lubricant to the bearing was still obscure. The more recent practice for high-speed bearings is to use only a part of the available bearing surface at the top and bottom of the bearing and use the remaining space to build up the oil film under the journal. Bearings made in this manner generally permit of the use of far higher surface speeds and pressure intensities than those of the older type.

J. Y. DAHLSTRAND,
Wellsville, N. Y. Chief Eng., Kerr Turbine Co.

Piston Packing Burns Out

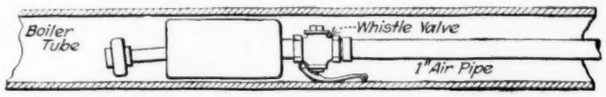
I am up against a puzzling problem. We have two Ideal engines 9 x 10 in., making 205 r.p.m. with 100 lb steam pressure and direct-connected to generators. They sometimes run for several weeks without giving trouble, then, presto! the piston rod gets so hot that the packing in the box is burned out. We use a good grade of cylinder oil fed by automatic force-feed pumps. The packing is of a good grade, costing $1.50 per pound, and is kept in A-1 condition. Sometimes the heating occurs shortly after repacking and at other times not for some weeks.

I have asked different engineers, including the experts from the engine shop, and no one seems able to explain the cause. Recently, we spent $1000 having the engines overhauled and put into good condition by the makers, but still the rod will occasionally heat and burn the packing. The piston and rod are properly centered, and the load is never excessive. I have never heard of a similar case, but some readers may have been troubled in this way and solved the problem.

Portsmouth, Ont., Canada. JAMES E. NOBLE.

Air Control for Tube Cleaner

In removing scale from a fire-tube boiler, we use a compressed-air tube cleaner that is attached to a 14-ft. length of 1-in. pipe. In operating this cleaner it required one man to open and close the air valve every time the cleaner was changed from one tube to another. I found an old whistle valve and screwed it to one end of the tube cleaner, attached the pipe to



WHISTLE VALVE ATTACHED TO TUBE CLEANER

the valve and left the valve on the air line open. When the cleaner enters the boiler tube, the lever on the whistle bears against the tube and opens the valve, thus admitting air to the cleaner. When the cleaner is withdrawn from the tube, the spring closes the valve. This arrangement is shown in the accompanying sketch and is repeated each time the cleaner is pushed into the tube.

JOSEPH MCCUMBER.
Grinnell, Iowa.

Fuel-Saving Suggestions

In *Power* of Dec. 11, Mr. Bromley gives directions for saving coal in power plants. The article is very good, and with a comment on the method advocated of cleaning fires I would give it approval. "Jumping" ash and clinkers over clean fuel is impractical and results after hard work in only half-clean fires. It is not done so "in our set this season." I also believe Mr. Bromley overlooked the great advantages of shaking grates in furnaces. Now, above all times, it is opportune to recommend the shaking grate, as it is without doubt a valuable asset to fuel saving.

The shaking grate is not new. It was introduced many years ago, and the principle was recognized at once as sound and logical. The very desirability of some such device induced many makers to go into the business of turning shaking grates out as fast as possible.

The result was that many of the grates were not strong enough for the hard usage encountered in many of the installations, and the shaking grate got a "black eye" from which it has not yet recovered, notwithstanding the great improvements made.

In every instance where a stationary grate is used, a large saving of fuel would be made if a shaking grate were substituted, and I believe Mr. Bromley will agree that every effort should be made to induce engineers to use all their influence to have this style installed, instead of the original and old-fashioned stationary grate.

Somerville, Mass. JOHN M. COLEMAN.

["Jumping" the fire was considered because of the very extensive use of the stationary grate. The shaking grate is desirable.—Editor.]

Static Electricity from Gasoline

The following experiment will show that gasoline will create enough electricity in flowing from a spigot to ignite itself. Insulate a can from the ground and draw gasoline into it from a spigot near to but not touching the can, and the composition of the gasoline is such that it will create static electricity in the can and discharge in sparks when it gets up to the neck of the can, so that it can jump across and an explosion will occur. This has happened in several instances, and even if the spigot is grounded, electricity will still be generated in the can. The only way to prevent the explosion is to ground the can to carry it off.

This is a new one on me, and it seems to be the composition of the gasoline that causes it, as other liquids have been tried with no such results. D. R. HIBBS.

New York City.

Controlling Smoking Chimneys

The smoke-preventing system described on page 718 of the Nov. 27 issue of *Power* is very good for a large power plant, but it would be rather expensive for a small one. Following are a couple of methods that may be employed to watch the smoke and assist in keeping it down to the proper density and that can be used by almost any plant, no matter how small. Some of the small plants have more trouble with smoke

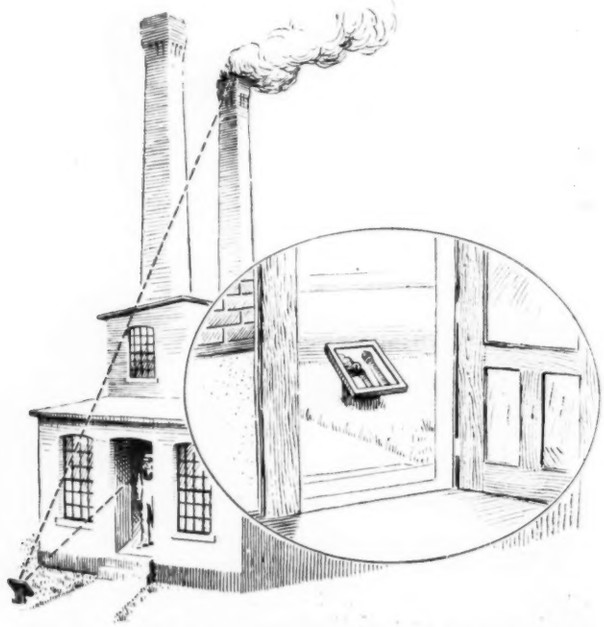


FIG. 1. SMOKE OBSERVATION MIRROR IN THE YARD

than the large ones, as they do not have as efficient methods of operation; and there is more complaint in a small place, as many of the homes are owned by the tenants.

One method of smoke observation is to place a post in the boiler-house yard with a mirror attached to it and set at such an angle as will enable the boiler attendant when standing in the doorway (see Fig. 1) to easily observe whether his chimney is smoking or not. If it is, he can remedy the cause.

The other method can be used only in boiler plants in which the chimney rests on the top of the boiler. A 2-in. pipe is put through the stack at such an angle that the fireman can see through it from the floor. The pipe has several large holes drilled through it to admit the smoke, but not large enough to affect the

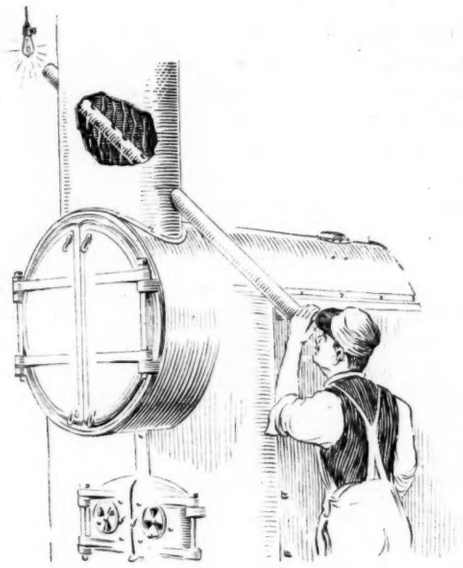


FIG. 2. SMOKE OBSERVATION PIPE IN STACK

draft. An electric light is hung at the top end of the pipe, as shown in Fig. 2. When the fireman looks through the pipe, he can see at a glance whether the light is clearly visible or not. The clearness with which the light can be seen, of course, indicates the smoke condition. D. R. HIBBS.

New York City.

Unsatisfactory Plant Conditions

When I took charge of this plant, which comprises three generating units of medium size, I found that the governors on two of them were so badly corroded and sticky that with the least fluctuation of steam pressure or load they would race badly or slow down. The governors were immediately cleaned and put in order, and no further trouble has ever developed. The smallest of the three engines would remind one more of a trip-hammer than a steam engine. The former chief informed me that the knock was born in the small unit and that no means could be found to remove it, but I can truthfully say now that I never saw a more quiet running engine, and a coin will stand on edge on different parts of the engine and bedplate.

A great deal has been said on the coal question, and most writers hold to the point that the engineers are the ones charged with the saving of coal. To a certain extent this may be true, but assuming that one has done all in one's power to cut down on coal, such as cleaning boilers, stopping leaks in boiler walls and cleaning stacks, and is getting the best results possible under existing conditions, but is still burning more coal than should be consumed, with black smoke belching from the chimney continuously, and after satisfying oneself that

an investment of a few hundred dollars would cut that coal bill, the owner should refuse to make the investment, what should one do? I think I know the answer most engineers would make. M. E. WEBBER.

Syracuse, N. Y.

Sandpapering Brushes

In sandpapering the brushes of modern motors, I have found that, where the brushes fit well in the holders, it does not make much difference whether the sandpaper is drawn in one direction only or back and forth. In up-to-date machines the brushes usually make a good fit in the brush-holders. In the older machines the brushes often fitted loosely in the holders, and then difficulty was likely to be encountered unless the sandpaper was pulled only in the direction of rotation of the machine. However, it is safe always to pull the sandpaper in one direction; that is, in the direction of the rotation of the machine. T. A. NASH.

New York City.

Warning of Impending Danger

Some readers of *Power* no doubt have had experience with flywheel explosions and are "alive to tell of them." There surely must have been some warning or a series of warning incidents, if properly interpreted, preceding the explosion. From experience we recognize the sound when valves "grind" for want of better lubrication or when water is heard in the cylinders. If all strange sounds are immediately investigated, there is a remedy for such things if applied in time. While alone on watch, I have often wondered what incident would occur? What sound would be heard which would be a sign of impending disaster—that the flywheel was on the point of rupture? How many readers could describe the series of events leading up to a flywheel explosion? Would not such a discussion be of great value?

A young man walked into our station one night, introduced himself as an engineer and asked to look around. I showed him around, answering his questions and in turn asking some. We stopped in front of the 300-kw. unit which was running at the time, and he asked if I had had any experience with flywheel explosions. My answer was in the negative, but in reply to the same question to him, he said that he had and told the following:

Several years previously he was working in a certain manufacturing plant as a sort of wiper and making himself generally useful about the place. There were two units, duplicates. The flywheel of each weighed approximately 14 tons and operated at 100 r.p.m. One day toward noon he walked into the engine room to help fill cups, etc., during the shutdown. Suddenly a "whistling" sound came from the flywheel—something that had never been heard before. An old timer at engineering urged an immediate shutdown of the engine as a flywheel explosion was impending. The whistling increased while the throttle was being closed, and the men "scattered for the open air." The whistling continued as the engine gradually slowed down, then the flywheel suddenly went to pieces; but the damage was comparatively slight, for which everyone felt grateful to the old timer.

According to the young man's narrative, then, if an engineer heard a whistling or other unusual noise coming from a revolving flywheel, he would be justified in shutting down and investigating. Anyway, by so doing he would be playing on the safe side. I hope there will be a discussion that will give a clue in regard to such explosions, and surely there are many engineers who will appreciate it. THOMAS M. GRAY.

Middletown, N. Y.

United States Navy Service Flag

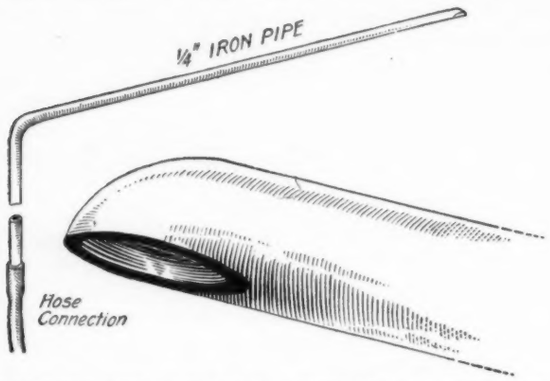
With the usual service flag there is no way of distinguishing the particular branch of service represented. Being in the Naval service, I took occasion to make a service flag for my own home and decided that anybody who should see it would recognize the branch of service represented. I took a white line and made some of the most attractive navy knots and placed the cord in a continuous line around the white panel. At the top and bottom there is a double Carrick bend and on each side, at equal intervals, a figure-of-eight and a square knot. Since sending the flag home, I have heard that it is considered not only attractive, but leaves no doubt as to which branch of the service I am in.

SERVICE FLAG TO DESIGNATE THE SERVICE

New York City. M. M. CLEMENT.

Cleaning Turbo-Alternators

The importance of keeping the windings and air passages of turbo-alternators free from dirt is well known and cannot be overstated, and it is not a difficult job with some types of generators at least. We use compressed air through a ¼-in. iron pipe, bent as shown in the illustration, for blowing out 5000-kw. generators.



BLOWPIPE FOR CLEANING GENERATORS AND MOTORS

The lance is long enough to reach halfway through the generator, and from the long-radius bend to the hose connection is about two feet; this serves as a handle, and it also indicates the direction of the blast when the lance is in the generator. With the end shields off the generator the lance may be inserted between the field and armature, and the powerful blast of air, issuing at right angles to the pipe, blows through the windings and laminations, effectually removing the accumulated dirt. It takes four men from eight to ten hours to do the whole job and get the machine ready for service again. H. W. MORREALL.

Utica, N. Y.

Preventing Lamps Burning Out

Recently, I had several flood lights to install on a 220-volt circuit, therefore the lamps were wired two in series. After the lights were put in service, considerable trouble was experienced with the lamps burning out, owing to voltage surges in the line serving the property.

I have been able to reduce our lamp loss from this cause by connecting, in series in the line, about a thousand feet of No. 8 wire, leaving the wire in the form of a coil, which seems to act as a choke coil. Since doing this I have lost only two lamps in two weeks. Previous to the installation of the coil the loss was two or more every night. C. W. YOUNG.

Tulsa, Okla.

[The experience related is no doubt a case of operating the lamp on too high a voltage. This could have been remedied by finding out the correct voltage and installing the proper lamps.—Editor.]

Regulation of Feed Pumps

A large number of plants using steam heating or drying coils, and draining the condensate and drips back to an open heater to save the heat as well as the water itself, lose a large part of the returns through the heater overflow because of the limited storage space and improper operation of the feed pump.

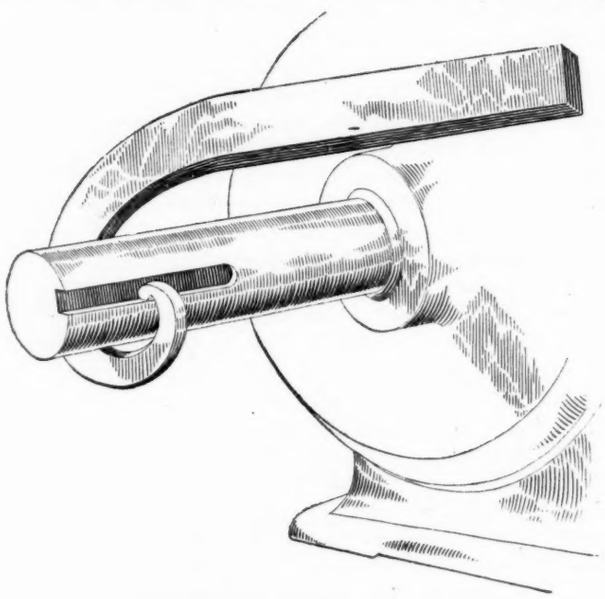
Frequently, the pump is speeded up and the boilers filled with water during times when the volume of returns is not sufficient to make up the feed supply and cold water is automatically supplied. The pump is then shut down, and the returns fill the storage space of the heater and overflow, carrying away valuable heat. The pump should be so adjusted as to deliver the return water continuously to the boiler at the rate at which it is coming back, and as a result none will be wasted at the overflow.

Such regulation of the feed pump in one plant cut down the use of makeup water by one-third and gave an even feed temperature of 210 deg. F.

Philadelphia, Penn. M. A. SALLER.

Spanner Wrench for Finished Shafts

The illustration shows a spanner wrench for shafts, which has proved so useful that I want others to know of it. It is made of 1 x ½-in. steel, and the same wrench can be used on shafts from one to six inches in diameter without damaging the keyway. The shape of the tool is the result of something like two years' evolution. It is christened the "Twister" and is used for rotating



WRENCH TO ROTATE A SHAFT

(by hand) armatures and the like during the process of erection, repairing and inspection, and of course it works equally well on other similar things. The need of something of the kind is shown by the condition of keyways on shafts so frequently found damaged by the use of monkey wrenches and pipe wrenches.

Brooklyn, N. Y. A. J. CAHEN.

A point about the arrangement of blowoff piping, which is often overlooked and may lead to a serious accident, is failure to see that the pipe system drains thoroughly by gravity to the discharge point. A pipe that remains partly filled with water, that becomes cold between the times, is likely to cause severe water-hammer that may break the fittings and may scald the operator.

Inquiries of General Interest

Collapsing vs. Bursting Pressure of Tubes—Will a flue or tube of a boiler resist a greater internal or external pressure? L. L. S.

On account of the impossibility of constructing flues or tubes of true circular form, or of their maintaining circular form when subjected to external pressure, they fail by collapsing from less pressure applied externally than the internally applied pressure required for bursting them.

Theoretically Maximum Percentage of CO_2—What is the theoretically maximum percentage of CO_2 in boiler-flue gases resulting from complete combustion of a pound of carbon? J. H. K.

With complete combustion, and only enough air present to burn the carbon, the flue gas would show only CO_2 and N, as all of the oxygen would be combined with the carbon. As air consists by volume of oxygen 0.207 part and nitrogen 0.793 part, the flue gas would show 20.7 per cent. of CO_2 and 79.3 per cent. of nitrogen, because CO_2 occupies the same volume as the oxygen from which it is formed.

Advantages of Subdivided Steam-Heating Surfaces—For warming a room by steam heat, what advantages are to be obtained by employing two direct radiators in place of one? C. C. P.

For the same amount of heat given out there will be the same amount of steam required, but when appropriately located, two or more radiators may be so placed as to give more uniform distribution of the heat throughout the space that is to be warmed and thereby effect a saving by not requiring overheating of a portion of the space to obtain sufficient warmth throughout the whole space. Another advantage is that with the heating surface divided the amount of surface used can be better adapted to requirements of weather.

Troublesome Radiator—In a low-pressure two-pipe gravity-return steam-heating apparatus fitted with direct radiators, one of the radiators fills up with water and will not circulate properly. What would remedy the trouble? A. W. F.

The radiator may not have large enough steam supply to maintain sufficient pressure for discharging the water against the pressure in the return main. This trouble is likely to occur when drips or other radiators at a higher level or more active radiators on the same level are connected into the same dry return line. If the troublesome radiator has ample steam supply, it should be made to return as well as others on the same level by giving it a separate return connected to the return main well below the water line of the boiler.

Variation of Power Required for Vacuum Pump—Is more power required for driving a vacuum pump with a high or a low vacuum? T. C. E.

The energy required depends on the net pressure or difference of pressure on each side of the piston. Hence with a single-acting air pump or any type of vacuum pump working at constant speed against atmospheric pressure, the higher the vacuum the greater the power required for its operation. But with a double-acting vacuum pump, operated at constant speed, the higher the vacuum the less the power required, as the average pressure on the discharging side becomes less the higher the vacuum in the condenser. With a perfect vacuum the difference of pressure would be 0 and the power required for operation of the pump would be only that required for overcoming friction.

"Lead" or Clearance of Large Bearings—What is a practical method of determining the setting that should be given to the boxes of a large crankshaft? F. M. F.

For stationary engines the amount of "lead," or radial clearance, is commonly adjusted by setting the capscrews or nuts down hard and then backing them off such a fraction of one turn as to permit a clearance between the journal and bearing that has been determined to be suitable for the special conditions. For large bearings having good working surfaces, radial clearance of 0.008 to about 0.014 in. usually will be found satisfactory. The actual amount of clearance obtained by "setting down hard and backing off" may be approximately estimated by multiplying the pitch of the screw threads by the fraction of a complete turn backed off; thus with screws having 7 threads per inch, backed off "one-half of one flat" of a hexagonal nut or bolt head, or $^1/_{12}$ of a complete turn, the approximate clearance would be $^1/_7 \times {}^1/_{12} = {}^1/_{84}$, or about 0.012 in.

Check Marks on Drawings—What are the advantages and disadvantages of leaving check marks on mechanical drawings? J. A. P.

The purposes of mechanical drawings are better served by omission of any lines or markings that do not add to exactness of interpretation. There can be no objection, however, in leaving check marks on private copies of drawings in hands of the makers as information for what it may be worth, to indicate that the dimensions or other features check-marked have been criticized or have received special consideration. But the presence of such marks detracts from general clearness of representation and from concentration of the reader, and it is better to omit them from drawings intended only to impart information of design or construction, unless the marks are used sparingly and for attracting special attention.

Computing Power of Compound Engine—What is the formula for computing the indicated horsepower of a compound engine? R. D. B.

The power developed in each cylinder may be estimated separately as a simple engine by the usual formula

$$I.hp. = \frac{PLAN}{33{,}000}$$

in which

P = Mean effective pressure, lb. per square inch;
L = Length of stroke, in feet;
A = Area of piston in square inches;
N = Number of single strokes per minute.

Then, adding together the number of indicated horsepower for each cylinder gives the total power developed.

When, as is generally the case, there is the same length and number of strokes in each cylinder, a more convenient method of computing the gross power of the engine is to assume that the m.e.p. of both cylinders are combined and referred to one of the cylinders (as the low-pressure cylinder) and assume that the whole power is developed in the cylinder thus referred to. If d = diameter of the high-pressure cylinder, D = diameter of the low-pressure cylinder, M = m.e.p. of the high-pressure cylinder, m = m.e.p. of the low-pressure cylinder, then the m.e.p. of the high-pressure cylinder referred to the low-pressure cylinder would be $M \times d^2 \div D^2$; the combined m.e.p. referred to the low-pressure cylinder would be $\frac{Md^2}{D^2} + m$, and the gross power of the engine would be given by the formula

$$I.hp. = \frac{\left(\frac{Md^2}{D^2} + m\right) \times L \times 0.7854D^2 \times N}{33{,}000}$$

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Effects of War Conditions on Cost of Electric Service

Owing to the number of requests for regular institute meetings by the different sections of the American Institute of Electrical Engineers, it was decided to hold intersectional meetings, in which nearly simultaneous sessions are held in two or more cities, to consider the same papers. In accordance with this plan the 336th meeting of the institute was held in Boston, Jan. 8; in New York City, at the Engineering Societies Building, Jan. 11, and in Chicago, Jan. 14. The same paper was presented and discussed at all three places.

The success of these meetings, especially at this time, when the engineers of the country are overtaxed with the duties involved as an outcome of the war, thoroughly justifies these intersectional meetings. A record number was in attendance at all three meetings. One paper, "Effects of War Conditions on Cost and Quality of Electric Service," by Lynn S. Goodman and William B. Jackson, was presented at all three meetings. Mr. Jackson presented the paper at Boston and New York. I. M. Cushing, secretary of the Boston section, presided at the Boston meeting, and President E. W. Rice at New York City.

Mr. Jackson, as an introductory to the presentation of the paper in New York, gave a brief outline of the war situation for the past year, pointing out that when viewed in a narrow way the outlook was not very promising, but viewed with a broad range of vision the outlook for the United States and her allies could be nothing else but optimistic, and that the outcome would be of material benefit to this country. Likewise in the power industry, when viewed in a small way, the outlook creates pessimism, but when considered from the larger angle there is every reason to believe that the situation will be successfully met.

The paper deals more particularly with the effect of war conditions upon electric-light and power service, but the principles relate in their broad application to every kind of public-utility service.

Directions in Which the Effects Appear

The principal directions in which the effects of war conditions on electric service appear are:

1. In relation to operating: (a) In increased salaries and wages paid for operating; (b) in difficulty of retaining trained operatives and, conversely, the need to operate with partly trained forces; (c) in increased cost and difficulty of obtaining fuel and in reduction of its uniformity and quality; (d) in increased cost of other supplies and materials for operation and maintenance; (e) in the need for protecting the properties against enemy agents; (f) in increased taxes; (g) in possible decrease of consumption of electric power by ordinary customers; (h) in possible changes of load factor.

2. In relation to extensions of plant: (a) In the necessity in many cases for quickly caring for large accessions of permanent and temporary business; (b) in increased cost over normal for plant required to care for additional business; (c) in high cost for money and difficulty of obtaining it at any rate considered reasonable in normal times; (d) in the difficulty of obtaining equipment in reasonable times of delivery.

The effects of the war conditions are being manifested not only in the matter of heavy increases in operating costs, but also in the matter of extraordinary increases in cost for new plant required to care for added business. These conditions have already increased the operating expenses of the electric companies of this country to the extent of over $116,000,000 per year, as hereafter shown. This points to the necessity of readjustment to the new conditions without delay, while at the same time requiring readjustment to abnormal labor conditions.

An analysis of the United States Census statistics shows that the increase in the average wages paid per employee (exclusive of general officers, managers and superintendents) during the ten years from 1902 to 1912 was 11 per cent. During the war period thus far, salaries of officers, managers and general superintendents have in general not greatly increased, but increases in wages in the operating departments have ranged from 15 to 50 per cent., and it is the opinion that 25 per cent. may be taken as the average increase thus far occasioned by the war.

Under normal growth from 1912, at the rate indicated by the growth during the previous ten years, we find that the salary and wage disbursements of electric companies in the year 1917, had there been no unusual disturbance, should have amounted to $90,000,000, of which one-seventh would have been for general officers', managers' and superintendents' salaries and six-sevenths for wages. From this it is seen that the increase in wages of 25 per cent. means an outlay on the part of the electric companies of $19,000,000 for the year.

Increased Fuel Cost to Electric Companies

Estimates based upon the United States Census reports show that the fuel cost for all the electric companies in the United States would have reached $50,000,000 for the year 1917, under normal conditions of the country, and would have amounted to about 60 to 65 per cent. of the normal generating expense. Definite information as to the amount of increase in fuel cost for the whole country is not available, but from information obtained from various sections of the country the conclusion is arrived at that the average cost per ton of coal to electric companies has increased a little more than 100 per cent. on account of war conditions, and that 100 per cent. is not far from correct. On this basis the increase in total cost due to the enhanced price per ton of fuel is $50,000,000. A conservative figure for the increase in tonnage due to lower quality and non-uniformity of grade is 10 per cent., which means an added increase of $10,000,000, making the total increase $60,000,000.

An estimate of the output from steam-driven electric central stations which might have been expected for 1917 under normal conditions shows 13,000,000,000 kw.-hr., and an average requirement of three pounds of coal per kilowatt-hour of output shows that the fuel requirements would amount to not over 20,000,000 net tons, which is approximately 3 per cent. of the estimated output from the mines for 1917. It is thus seen that a relatively large reserve supply of coal in the hands of every electric company would tie up but a very small part of the coal supply of the country and this supply would be widely distributed and to a certain extent would be in proportion to the populations and industrial importance of the several sections of the country.

The indications are that the cost of materials and supplies other than fuel, which is estimated as a little over 15 per cent. of the total operating expense, has increased as much as 75 per cent. Such an advance in this expense means an increase in expenditures in the neighborhood of $30,000,000.

Increased Taxes Paid by Electric Companies

Estimates based on the United States Census returns indicate that the 1917 taxes paid by electric companies might normally have reached $25,000,000. The proportion of gross revenue required for taxes has apparently been increasing year by year, having been slightly over 3 per cent. in 1902, a little over 3.5 per cent. in 1907, and nearly 4.5 per cent. in 1912. An estimate of the amount of the expense which may be expected to be added to the cost of electric service throughout the country from increased taxes is difficult of determination, but we may hazard a guess that the increase over normal expense will lie between $5,000,000 and $10,000,000 for the year 1917.

Summing up the foregoing amounts shows that the extra expenses now imposed on the electric companies on account of war conditions amounts to the immense aggregate per year, as follows:

Increased salaries and wages chargeable to operating	$19,000,000
Increased cost of fuel	60,000,000
Increased cost of other materials and supplies	30,000,000
Increased taxes	7,500,000
	$116,500,000

This amounts to a quarter of the normal estimated gross revenue for 1917 of all the electric companies, and it wipes out two-thirds of the sum that would have been available for interest, dividends and surplus. It does not include

additional expenses caused by the difficulty of retaining trained operatives and the cost of protecting the properties against malicious interference, the magnitude of which we are unable to estimate. It puts the electric companies in a critical position, which is rendered more ominous by the impossibility of foretelling how much larger these extra expenses may become in future months.

Effect of War Prices on Power Industry

The effect of war prices on the electric-light and power business may be shown in the aggregate. The United States Census of central stations shows that the total revenue received from operation and other sources by all central electric-light and power systems (including both hydraulic and steam stations) in 1912 was in round figures $302,000,000 and the total operating expenses, including taxes and renewals and replacement expense, but not including interest on debt, was $184,500,000, leaving a total income of $117,500,000. The reported cost of construction and equipment was $2,176,000,000. Extension of these totals to the year 1917 shows that under normal growth the total revenues in 1917 would have reached $475,000,000 and the operating expenses, including taxes and renewals and replacement expense, would have reached $290,000,000, making the total income before deducting interest on debt, $185,000,000. Estimating the reported cost for construction and equipment would have grown to $3,500,000,000, an increase of 60 per cent. in five years, the income mentioned would represent 5.3 per cent. of this cost of construction and equipment. If no other factors entered into the problem besides increases in cost of operation, and assuming these increases effective over the whole year, the fuel expense, as before pointed out, would increase $60,000,000 for 1917, other supplies $30,000,000, labor expense $19,000,000 and taxes $7,500,000, representing an aggregate increase of operating expenses for these items of $116,500,000. This is an increase of 40 per cent. in operating expenses, and it reduces the divisible income to $68,500,000, which amount is equivalent to less than 2 per cent. on the cost of construction and equipment. This percentage is still lower in the case of the steam-electric systems of the country taken alone, and additional expenses for training new employees and the lowered efficiency of such employees, the cost of special policing, etc., reduce the amount still further.

What has been pointed out in the foregoing regarding the effect of war conditions on central-station electric service is also applicable to the cost of power produced by private power plants. The immensity of this field is seen by reference to the United States Census of Manufacturers for 1914, in which the total primary power reported as used in this field aggregated 22,500,000 hp. (exclusive of isolated electric plants for office buildings, hotels, etc.), of which 15,700,000 hp. was comprised of steam-driven equipment and only 3,900,000 hp. was in the form of purchased electric power. The central-station steam and water-driven electric generating capacity in 1912 was only 7,500,000 hp., with a probable 9,000,000 hp. in 1914.

Power Output of Industrial Plants

Considering the output of power by the industrial plants using steam power, which do not now purchase electric current, estimated on the basis of the capacity of equipment as reported for 1914, operating at the equivalent of full load for a sixth of the time, the total horsepower output would amount to 23,000,000,000 hp.-hr. It is safe to say that at least three-quarters of this is such that the exhaust steam cannot be effectively used for heating purposes and there would be a possible saving of at least 1.5 lb. of coal per horsepower-hour through service of this three-quarters from central steam-driven electric stations, making a total saving in fuel of 13,000,000 tons of coal per year under the industrial plant output for the year 1914. The saving would be much greater when considering only the more modern and economical central stations. The same considerations apply to the field of isolated building and hotel electric plants where conservation of coal amounting to millions of tons could unquestionably be effected.

The result of the increased cost of producing electric power in England, and also the curtailment of certain classes of service not yet experienced in this country, has been quite a universal increase in rates, in some cases flat percentage increases of the same amount for light and power, in other cases differing percentage increases for light and power, and in still others increases depending upon changes in cost of fuel. These flat percentage increases have varied from less than 10 per cent. to as high as 50 per cent. over the rates in effect prior to the war, London rates having been increased 50 per cent., according to the London *Electrical Review*.

The authors in the paper also point out that the economical central power-generating station is the proper medium for the supply of the large-power requirements arising on account of the war, and the many advantages of this means of producing and distributing power. These advantages, they say, are so large that it is advisable for the Government to use every reasonable means to encourage the central-station companies and discourage individual power plants during the period of the war. Certain operating economies and changes which might be adopted by the central-station companies, if forced to it by war conditions, are also considered.

The paper brought forth a vast amount of discussion. Among the opinions expressed was that when the exhaust steam could be used for heating and manufacturing purposes, power could be produced just as cheaply, in the isolated plant, if not at less cost, as in the central station.

H. M. Hobart, who had recently returned from England, called attention to the 50 per cent. increase in the rates for electric service in London being an exceptional case, as it was doubtful if there had been any increase in the rates in many localities in that country. He also pointed out that the increased cost of each item entering into the production of power should not be considered as directly affecting the cost of power, since the output of the central station has also greatly increased.

The pooling of power of both central and private plants, and if necessary the commandeering of private plants, was suggested as a means to help supply power to the essential industries for carrying on the war.

In Re Proposed Water-Power Legislation

"Joint letter" from the Secretary of War, Secretary of the Interior and Secretary of Agriculture, addressed to the President, regarding the proposed water-power bill.

My Dear Mr. President: We transmit herewith for your consideration draft of a proposed bill for the development of the water powers of the United States upon navigable streams, public lands and national forests. The measure was prepared under our direction by members of our departments who have had most to do with the water-power problem, and we believe it will be likely to secure extensive development of this resource, with due regard to the public interests as well as those of the developers.

It embodies the fundamental principles of several bills now pending in Congress, and an effort has been made to avoid or cure their defects. The principal features of the proposed bill are as follows:

Administration

By a commission composed of the Secretaries of War, Interior and Agriculture.

The Shields bill (navigable waters), by the Secretary of War.

The Ferris bill (public lands), by the Secretary of the Interior.

Period of Lease

The bill proposes to lease the water-power privilege for a period of not exceeding 50 years. At the end of that time the project may be (a) taken over by the United States; (b) re-leased to the original lessee; (c) leased to a new lessee.

The Ferris and Shields bills also provide for leasehold periods of not exceeding 50 years.

The attached bill proposes that at the end of the leasehold period the project may be taken over as follows: All prop-

erty owned and held by the licensee then valuable and serviceable in the development or distribution of power, together with any locks or other aids to navigation constructed by the lessee, upon payment of "the fair value, not to exceed actual cost of the property taken, plus such reasonable severance damages, if any, as may be caused by the separation of said property from property valuable, serviceable and dependent as above set forth, but not taken," such value not to include any rights granted by the United States, good will, going value or prospective revenues. Further, the values allowed are not to exceed the actual reasonable cost of the property at the date of its acquisition by the lessee.

The Ferris bill provides that the United States may take over at the end of the leasehold period all property in the project to the point of distribution, upon payment of actual cost of water rights, lands and interests therein, and the reasonable value of all other property taken over, but not including franchise value, good will or other intangible elements.

The Shields bill provides that the United States may take over all the property of the grantee which constitutes part of the plant or is dependent in whole or in part upon it, upon paying to the grantee just compensation for said property, together with the cost to the grantee of the locks or other aids to navigation, no value being allowed for the rights granted by the United States for good will or anticipated profits.

Regulation of Service and Charges

The attached bill provides for regulation by the Federal Water-Power Commission of interstate power; also of power in any states where no state regulation is had. Intrastate power is to be regulated by state utility commissions, where same exist.

The Ferris bill provides for regulation of service and charges and of stock and bond issues where there is interstate transmission or in states having no commission by the Secretary of the Interior.

The Shields bill provides for the regulation of interstate power by the Interstate Commerce Commission, other power developed to be regulated by the state in which the service is rendered. No provision is made for control in those states where there is no public-service commissio

Charges

The bill proposes that the lessee must pay the United States reasonable annual charges, to be fixed by the water-power commission and specified in the lease, in no case to be less than 10 cents per horsepower per annum. No maximum is fixed. Where the lessee builds, maintains and operates locks or other aids to navigation, the commission may take that fact into consideration in fixing charges, also assessing against the lessee any benefits he may obtain from the construction, operation and maintenance by the United States of headwater improvements or navigation structures.

The Ferris bill provides that annual charges, measured by the power developed, shall be collected.

The Shields bill provides that payment shall be made for any lands of the United States used or occupied by the lessee, the charges to be based on the value of the lands as fixed by the Secretary of War, his discretion being limited by the requirement that the value must be ascertained by the rules in force in the state where the lands are located in proceedings where private property is sought to be taken for a public use. It also requires that the grantee shall pay the United States reasonable charges in consideration of the construction, operation and maintenance by the United States of headwater improvements.

Disposition of Receipts

The attached bill provides that all receipts shall be placed in the Treasury of the United States; that 50 per cent. of the proceeds from national forests be expended in construction of roads therein; that 50 per cent. of receipts from public lands be placed in the reclamation fund; that 50 per cent. of receipts from navigable streams be expended in the maintenance and operation of dams and other navigation structures of the United States; and that all proceeds from Indian reservations shall be placed to the credit of the Indians.

The Ferris bill provides that all receipts from public lands shall be placed in the reclamation fund, and upon return to that fund, be divided equally between the United States and the states in which the development occurred.

The Shields bill provides that proceeds shall be set aside as a special fund for the maintenance of dams and headwater improvements.

We believe that some such legislation as is here proposed, if enacted, would mean the early development of a considerable portion of our water-power resources, with a resultant saving in fuel and a considerable lessening of the present demand on our transportation facilities caused by the moving of coal and other heavy fuels.

Cordially yours,

Newton D. Baker.
Franklin K. Lane.
D. F. Houston.

The President,
The White House.

Interpretations by the Boiler Code Committee

Following are the most recent interpretations by the Boiler Code Committee:

Case No. 177—Inquiry: Is the type of removable dome as shown in Fig. 13 of the Code for use on horizontal return-tubular boilers permissible under the rules of the Boiler Code, or is it necessary that this dome be attached direct to the shell with a double-riveted flange for pressures over 100 lb.?

Reply: The construction shown in Fig. 13 is considered as a steam-boiler drum and not a boiler dome, and therefore does not come under Par. 194 of the Boiler Code.

Case No. 178—Inquiry: An interpretation is requested of the application of Par. 253 to the drilling of rivet holes in crowfoot braces. Is it permissible to punch holes in the shell full size where the brace is fastened thereto?

Reply: It has been proposed to revise Par. 253 to read as follows:

253. Drilling of Holes. All rivet and stay-bolt holes, and holes in braces and lugs, shall be drilled full size or they may be punched not to exceeed ¼ in. less than full diameter for material over ⅞ in. in thickness, and ⅛ in. less than full diameter for material not exceeding ⅞ in. in thickness, and then drilled or reamed to full diameter.

Case No. 179—Inquiry: In the use of steel castings for the construction of locomotive boilers, what class of castings shall be used under the specifications for steel castings given in the Boiler Code?

Reply: It is the opinion of the committee that unless the Code specifically distinguishes between Class A and Class B, either class is permissible.

Case No. 180—Inquiry: Is it permissible when calculating the maximum allowable pressure on a furnace of a vertical tubular boiler, that is stay-bolted and less than 38 in. in diameter, to determine the pressure that would be allowed under Par. 239 for a plain furnace, then add the pressure which would be allowed according to Par. 199 for the supporting value of stay-bolts?

Reply: It is the opinion of the committee that individual cases and specific diameters of furnaces could be calculated either by Par. 199 or Par. 239; that is, the maximum allowable working pressure cannot be determined by a combination of the two paragraphs.

The A. S. M. E. Boiler Code is at present under revision and the committee will be glad to consider any constructive suggestions.

The following is from a reply to a communication from the Erie City Iron Works requesting the approval of the committee of a design of 148-hp. horizontal water-tube boiler:

Your inquiry of the 6th requesting the opinion of the Boiler Code Committee regarding your new 148-hp. horizontal water-tube boiler has been referred to the committee, and in reply I am directed to advise you that it

has been a ruling of the committee for some time past that it will not express opinions on types of boilers, and it will therefore be impossible to comply with your request for an opinion. Yours truly, Calvin W. Rice, secretary.

Power Rate For Electrically Driven Ice Plants*

By Harry B. Joyce†

The increase in the operating cost of ice-manufacturing plants, particularly in the last year, caused by the continually rising fuel prices, the uncertainty of getting fuel at any price, together with unstable and unsatisfactory labor conditions, has forced a number of manufacturers to seek a cheaper source of adequate power and a method of eliminating, at least in part, some of their labor troubles. As electrical power supplied from central stations logically meets both of these conditions, a discussion of the various electrical rates in force in this section of the country, for the operation of these plants, seems opportune.

It is not the intention of this paper to go into the details of or explain the many advantages of electric drive for ice-manufacturing plants, but rather to attempt to present clearly the general principles and conditions of the power rates available.

Plant Must Be Operated To Fit the Rate

To secure the best or even a fair rate per kilowatt-hour for electrical power in most cases, it is impossible to operate the rate to fit the plant; the plant must be operated to fit the rate.

When an ice-plant owner or operator asks, "What is the rate for electrical power?" what he really wants to know is the rate per kilowatt-hour or the power cost per ton of ice. This question in the majority of cases can best be answered by "The best rate you can earn." This depends first on the way one can or will operate the plant; and secondly, on the kilowatt-hour consumption per ton of ice in the particular plant. Both of these items must be determined from the size or sizes of the compressors, the number of cans per ton, feet of pipe per ton, number and size of condensers, temperature of the condensing water, etc.

That it is possible to operate a plant so as to earn an adequate electrical rate per kilowatt-hour is proved by the many plants now operated by electricity.

Practically all the so-called refrigeration and ice-making rates are what is known as "high-tension, high-load factor, off-peak demand rates." That is, the power supplied is alternating current in excess of 2200 volts, the load factor is maintained above a certain definite value, only a limited amount of power can be demanded during certain hours of a day over a period of a year, and the cost is based either in part or wholly on the demand for power and not on the amount of power consumed. Let us therefore take up singly these various items and discuss principally the maximum demand and the electrical load factor, on which the cost of currrent per kilowatt-hour depends practically entirely when operating under this class of rate.

The United Electric Light and Power Co. defines the maximum demand, as do some of the other central stations operating in Greater New York, as the maximum fifteen-minute average demand measured during a period of one week from 12 o'clock midnight Saturday to 12 o'clock midnight the Saturday succeeding; that is, the average power demand is recorded every fifteen minutes, and the highest of these demands so recorded occurring in any week is the maximum demand for that week and on which the bill is rendered.

In other cities different methods of determining the maximum demand are in use, as are the periods of time over which the demands are effective. Buffalo, for instance, uses the highest average demand for two consecutive minutes to apply for a period of one month. In Chicago the maximum demand used is the highest thirty minutes' average demand for the off-peak rate and the highest three-minute average demand for the on-peak rate, both of these demands applying for a period of one month. This contract (Chicago), in addition to the demand charge, makes an energy charge of so much per kilowatt-hour consumed. It provides, however, that if the customer will operate his plant so as to maintain at least a 50 per cent. load factor (which will be defined later) at not less than a 200-kw. maximum demand, the cost of the current will not exceed one cent per kilowatt-hour.

The Public Service Electric Co. of New Jersey determines the maximum demand from inspection and defines it as either 70 per cent., 60 per cent. or 50 per cent. of the connected load, depending on whether this connected load is all in one motor, more than one motor under 50 hp., or more than one motor over 50 hp. Here, also, there is a service charge for each kilowatt-hour consumed and a deduction of 5 per cent. if the customer takes service at a voltage of 2400 volts or higher.

Determining Maximum Demand by Demand Factor

This method of determining the maximum demand by what is known as the demand factor, or the ratio of the maximum demand to the connected load, is greatly to the ice manufacturer's advantage, as the demand charged is based on 50 per cent. of the connected load, while the actual maximum demand is usually greater than 80 per cent. of the connected load. I know of one plant where, during the hottest months of the year, this demand factor was as high as 135 per cent., which incidentally proves clearly the dependability of the electric motor to carry heavy overloads.

Time will not permit of discussing more of these electrical rates in detail; but practically all rates that apply to this class of service are similar in that they contain practically the same provisions and conditions.

The electrical load factor, which actually determines the cost of current per kilowatt-hour under the demand rate should not be confused with the yearly ice-load factor. The electrical load factor is the ratio of the actual kilowatt-hours consumed during the period of time over which the maximum demand is measured, to the kilowatt-hours the consumer would have used had this maximum demand been used continually during this period. That is, since the charge based on the maximum demand is the same whether or not this maximum demand is used continually, it is readily seen that the longer this demand is maintained during the period, the greater will be the consumption of current at the same cost and consequently the cheaper the current per kilowatt-hour; in other words, the higher the electrical load factor the less the cost of current per kilowatt-hour and consequently the cheaper the ice.

I might also mention that the shorter the period of time over which the maximum demand is measured, the more it is possible to maintain this higher electrical load factor. It is much easier to maintain a constant or nearly constant load, and consequently load factor, for a week than it is for a month, and it is easier to do this for a month than for a year. Central-station records show that in a properly designed and operated plant, a weekly load factor of from 85 to 93 per cent. is easily maintained; also that a monthly load factor of from 80 to 90 per cent. can be maintained during the summer months and from 60 to 80 per cent. during the winter months, while the yearly load factor will vary from 35 to 60 per cent.

Some of the central-station companies, in addition to the demand charge for this class of service, make an addition or reduction to adjust the primary rate according to the price of coal. For instance, the companies operating in Greater New York now make an additional charge or deduction of 0.035c. for each 10 per cent. increase or decrease in the price of coal above or below $3 per long ton f.o.b. New York Harbor. This additional coal charge, however, as far as I can learn, is made only by the companies who base their rates entirely on the maximum demand and make no additional charge for the energy consumed.

By the term "off-peak" as related to rates is meant that the rates are made with the provision that only a limited amount of power will be demanded during certain hours of

*Paper read before the Eastern Ice Association, Atlantic City, November, 1917.

†Power engineer, United Electric Light and Power Co., New York City.

the day, over that portion of the year when the central stations are carrying their greatest load. This is usually either from 4 p.m. to 8 p.m. or from 4:30 p.m. to 8:30 p.m. during the months of November, December, January and February. The power demand during this time is limited usually to from 10 to 20 per cent. of the highest previous maximum demand of the year. These values, it has been found, are sufficiently high to permit the operation of the lights and auxiliaries, and even to provide the operation of a small compressor while the large machines are shut down.

Should this specified demand be exceeded during these hours, a penalty charge is made for each kilowatt of demand in excess of that specified or a special rate is put into effect.

As far as I can learn, all these rates, with the exception of the Chicago rates, are high-tension rates; that is, the power is supplied at a voltage of 2200 or higher, and the customer must furnish his own transformers where it is necessary to have a lower voltage for the operation of any or all of his motors and, of course, for his light.

Some of the central-station companies have incorporated in their contracts such provisions as a guaranteed load factor, a guaranteed demand factor, etc., while others make an addition or deduction if the line power factor is below or above a certain definite value. I think it has been shown that it works no hardship, but that the ice manufacturer must maintain as high an electrical load factor and demand factor as is possible to earn a reasonable rate. As for a reduction in rate for maintaining a high power factor, this can easily be done by the use of synchronous motors on the compressors, which will permit of maintaining practically any power factor desired.

Summary

Let me summarize what I believe to be the safest and most accurate way to predetermine or estimate the power cost per ton of ice when it is decided to change to electric drive. First determine the number of kilowatt-hours necessary per ton of ice and what changes will be necessary to operate your plant at a constant or nearly constant load for the time over which the maximum demand will be measured. Then have the central-station representative of the district advise what the average load factor is for similar plants operating in the neighborhood, also the cost of current per kilowatt-hour at this load factor under the rate according to which your plant will operate.

I believe that many, particularly those who are operating plants in the larger cities where central-station electric power is available, will be figuring on this question within the next year or two. At this time last year, there was not an electrically operated ice-manufacturing plant on Manhattan Island. Today there is one in operation, five plants being changed over from either steam- or oil-engine drive, and one new plant in the course of erection.

If it is my privilege to attend this convention next year, I hope to be able to present some very interesting figures on the operation of these plants, all of which are different not only in capacity, but also in the number of cans used per ton, feet of pipe per ton, size and number of condensers, some using cooling towers, some wells, and others river water. I hope at that time to be able to show that although all these factors affect in one way or another the necessary kilowatt-hours per ton of ice, a high load factor and consequent low cost of current per kilowatt-hour can be maintained, under all of the foregoing conditions, if the plants are properly operated.

Message to German Business Men

The Chamber of Commerce of the United States has sent to its members a referendum which is designed to ascertain whether American business men desire to notify German business men that they will not trade with them after the war unless the German government is made responsible to the German people. The National Chamber announces that 500,000 American business men are now voting on this question through national commercial organizations that are members of the National Chamber.

The referendum is the suggestion of the Boston Chamber of Commerce, and if it is adopted by the members of the National Chamber, it is hoped to communicate its result to German business men through international chambers of commerce and through German business men who are now visiting Switzerland, Holland, Denmark, Sweden and other neutral countries. Announcement by the National Chamber in regard to the referendum says: "The message cannot fail of its purposes, as Germany cannot hope for years to come to reëstablish satisfactory trade relations with Great Britain, Italy or France."

The message on which the vote is being taken is as follows:

Whereas, The size of Germany's present armament and her militaristic attitude have been due to the fact that her government is a military autocracy, not responsible to the German people; and

Whereas, The size of the German armament after the war will be the measure of the greatness of the armament forced on all nations; and

Whereas, Careful analysis of economic conditions shows that the size of Germany's future armament will fundamentally depend on her after-war receipts of raw materials and profits from her foreign trade; and

Whereas, in our opinion the American people for the purpose of preventing an excessive armament will assuredly enter an economic combination against Germany if governmental conditions in Germany make it necessary for self-defense; and

Whereas, We believe the American people will not join in discrimination against German goods after the war if the danger of excessive armament has been removed by the fact that the German government has in reality become a responsible instrument controlled by the German people; therefore, be it

Resolved, That the Chamber of Commerce of the United States of America earnestly calls the attention of the business men of Germany to these conditions and urges them also to study this situation and to coöperate to the end that a disastrous economic war may be averted and that a lasting peace may be made more certain.

Economizer Explosion Kills One Man

By the explosion of an economizer at the Remington, N. Y., "Short Line" power plant, one man was killed and the electric power and lighting circuits supplied by the plant were put out of service. The accident occurred a little after 10 o'clock on the night of Dec. 28. According to the newspaper account, the cause of the explosion is not known. It is stated, however, that earlier in the evening the power was shut off at the plant for more than an hour because of a leak in a valve on the economizer. That was repaired and electric service was resumed, when shortly afterward the economizer exploded.

The man who was killed was a water tender, and it is assumed from the position in which he was found that he was quite close to the economizer when the explosion occurred, as he was buried beneath the wreckage. One of the firemen in the boiler room was taken to the hospital.

Two of the seven boilers were damaged. These boilers were housed in a wooden frame building, the end of which was blown out and the boiler house more or less wrecked. Details of the accident will be published as soon as the facts can be obtained.

Christopher W. Levalley

Christopher W. Levalley, founder and chairman of the board of directors of the Chain Belt Co., died suddenly of heart failure at his home in Milwaukee, on Friday, Jan. 4. He was born at Manchester, Conn., in April, 1835, receiving his education in the schools there. When 14 years old he moved to Hartford, Conn., where he served an apprenticeship in a machine shop. At the outbreak of the Civil War he enlisted in the army. Following the war he went to St. Paul as superintendent of the St. Paul Harvester Co., later becoming general manager. It was at this time that he saw the necessity of a positive drive for harvesting machinery, and in 1891 he moved to Milwaukee, where he established the Chain Belt Co. In 1907 Mr. Levalley conceived the idea of driving a concrete mixer with a steel chain and using a

cast semisteel drum. These ideas were incorporated in what was known then as the Chain Belt Mixer, but which name has since been changed to Rex Mixer.

Mr. Levalley would have been 83 years old in April had he lived. From 1891 until 1916 he was president and general manager of the Chain Belt Co. In 1916 he was elected chairman of the board of directors and held this position up to the time of his death. He was also interested in the C. O. Bartlett & Snow Co., of Cleveland, and the Federal Malleable Co., of Milwaukee. He was a donor of many gifts to charitable institutions and only within the past year gave $100,000 to the Milwaukee Foundation.

Wartime Lubrication Economy

An example of lubrication economy is that of a large, well-equipped and well-managed plant in Boston. During the year preceding an investigation to cut the costs, the plant used 18,500 gal. of various oils with a total lubrication cost of $4425. Under the system used barrels of oil were distributed through the plant, and several were found to be leaking. The remedy was the construction of a central oilhouse containing metal tanks provided with key faucets. Much loss was also due to wiping up of engine frames and floors with waste, then thrown away or burned. To check this loss, an oil- and waste-saving machine was installed. This reclaimed considerable oil, and the waste could be reused many times. Cost of lubrication dropped from $4425 to $2570 within one year, a saving of almost 42 per cent.—*The Wall Street Journal Straws.*

What Power Did for a Dry Dock

To operate the dock of the New Orleans Dry Dock and Shipbuilding Co. by hand required the services of 64 men at an average cost of 25c. per hour per man, and the best time made was two hours for a small vessel. The dock has just been equipped by S. J. Stewart with eight motors, which make use of the old-style sucker pumps formerly operated by hand, by the use of which they are now able to make a lift in half an hour with the consumption of about $3 worth of current.

New Publications

THE DETERMINATION OF ABSOLUTE VISCOSITY BY SHORT-TUBE VISCOSIMETERS. Technologic paper, No. 100. Published by the Bureau of Standards, Washington, D. C. Size, 7 x 10 in.; 55 pages.

This publication reviews briefly the literature relating to the determination of viscosity and gives the results of further experimental work that has been done. The conclusion is reached that water is not a suitable liquid to use in finding the relation between the viscosity and the time of discharge for short-tube viscosimeters, and that Ubbelohde's equation and all others based on it are seriously in error. The paper is now ready for distribution, and those interested may obtain a copy by addressing a request to the Bureau.

Miscellaneous News

Regulation of Coal Exports during 1918 announced by the Fuel Administration limits shipments strictly to war uses.

A Boiler Flue Blew Out at the Barnet leather plant, at Little Falls, N. Y., on Dec. 31, severely scalding two men who were in the boiler room at the time of the accident.

The Boiler of a Pennsylvania R.R. engine attached to a freight car exploded at Metuchen, N. J., on Jan. 8, seriously injuring two men, one of whom died a few hours later in a hospital.

The Power House and Machinery of the municipal light and water plant at Marlington, W. Va., were destroyed by fire on Jan. 8. The fire was discovered over the boiler room. The cause is unknown.

A Boiler Explosion wrecked the Home Laundry at Delaware, Ohio, on Jan. 8 and decapitated the proprietor, T. E. Fox. The explosion occurred when Fox turned cold water into the empty tubes of the boiler, under which a hot fire was burning.

Flywheel Explosion at Hawarden, Iowa—Operation of the Hawarden, Iowa, municipal electric plant was interrupted for a time when the flywheel of one of the engines driving a generator exploded on the night of Jan. 2. Damage to the building was confined mostly to the walls opposite the flywheel and to the roof above it. It will cost about $4000 to repair the damage done to the engine and buildings. Temporary service was obtained from a reserve engine as soon as it could be put in running order. Fortunately, no one was injured.

Obituary

Malcolm Alexander, formerly superintendent of the old Brooklyn Union Gas Co., with which he was connected for thirty years, and later in the harbor transportation business, died at his home in Brooklyn on Jan. 11, at the age of 88 years. He was a native of Glasgow, Scotland.

Personals

E. B. Craft, W. F. Hendry and **E. H. Colpitts** have been appointed assistant engineers of the Western Electric Co.

Franklin T. Chapman, formerly connected with the Olympian Motors Co., of Pontiac, Mich., is now assistant general sales manager of E. F. Houghton & Co., Philadelphia, Penn.

Harry V. Hunt has resigned as superintendent of the Hooven, Owens, Rentschler Co., at Hamilton, Ohio, to accept the position of general superintendent of the Consolidated Press Co., at Hastings, Michigan.

J. S. Pandiani, formerly manager of the meter and supply department of the Italian Westinghouse Co., is now the Italian trade representative of the Esterline Co., of Indianapolis, Ind., with headquarters at Via Mario Pagano 27, Milano.

Russell T. Gray, formerly advertising manager of the Haynes Automobile Co., and more recently secretary of the Shuman Advertising Co., has opened an office in the First National Bank Building, Chicago, as an advertising engineer. Advertising service will be rendered a limited number of clients in the technical field. Technical advertising in trade papers and magazines as well as all forms of engineering catalogs and direct-by-mail advertising will be handled.

Engineering Affairs

The National Association of Stationary Engineers, No. 9, of Atlantic City, will hold its sixth annual banquet and entertainment at the Wiltshire Hotel, on Saturday evening, Jan. 26.

The Boston Section of the A. S. M. E. will give a reception to Charles T. Main, the new president of the American Society of Mechanical Engineers at the Engineers' Club, Boston, Mass., Tuesday evening, Jan. 22. This will be one of the big events of the Boston Section this season. Prof. Lionel S. Marks will speak briefly on the career of Mr. Main. H. C. Balch, of the Boston "Transcript," just back from France, will speak on "Engineering at the Front," as he saw it.

The Association of Iron and Steel Electrical Engineers has announced the following meetings: The Cleveland Section on Jan. 26, subject not yet announced. The Philadelphia Section on Feb. 2, at which H. G. Steele, of the Pittsburgh Transformer Co., will speak on "Mill Type Transformers." The Pittsburgh Section will meet on Feb. 16 at the Hotel Chatham, at which David L. Lindquist, chief engineer of the Otis Elevator Co., will present a paper on "A. C. and D. C. Skip by Hoists."

The Aldred Lectures at Johns Hopkins University—Through the generosity of J. E. Aldred there has been founded in the Department of Engineering of Johns Hopkins University, of Baltimore, a course of lectures on "Engineering Practice." The lectures will deal with the practical phases of engineering problems, rather than with theory, and will consist of three lectures each on general subjects in civil, electrical and mechanical engineering. They are given on Wednesday evenings at 8 o'clock, in the auditorium of the Civil Engineering Building. Those of particular interest to "Power" readers are "Steam-Electric Power Plant Design," given on Jan. 16 by A. S. Loizeaux, electrical engineer of the Consolidated Gas, Electric Light and Power Co., of Baltimore; and "Coal and Its Combustion in Boiler Furnaces," by E. G. Bailey, president of the Bailey Meter Co., Boston, to be given Mar. 13. The lectures are open to the public.

New York Engineers Granted Charter—The New York Chapter of the American Association of Engineers was established on Wednesday evening, Jan. 16, at the Hotel McAlpin, when the charter granted by the national organization was formally presented by President Edmund T. Perkins. The keynote of the meeting was sounded by Mr. Perkins, the principal speaker, with the subject, "The Engineer's Relation to Society." He urged the men to broaden their social and civic activities and to pay more attention to the human equation in engineering. Alexander Potter complimented the association on its national success with the problems relating to the human and business side of the engineering profession. A. H. Krom, general secretary of the A. A. E., gave a summary of the activities of the national organization and urged the members to promote the work and coöperate with all technical societies as well as to acquaint engineers with the fact that this is a business organization in a field of its own and which conflicts with none. E. J. Mehren, editor of the Engineering News-Record; S. J. Stone, A. C. Davis and others put forward valuable suggestions during the discussion. The New York office is at 220 West 42nd St., and the officers are: R. H. Vanderbrook, chairman; I. L. Birne, secretary.

Trade Catalogs

Link-Belt Silent Chain for Rubber Mill Machinery. Link-Belt Co., 39th St., Stewart Ave., Chicago, Ill. Book No. 299. Pp. 24; 6 x 9 in.; illustrated.

"Hydro" Gas Meters. Bacharach Instrument Co., Pittsburgh, Penn. Catalog E. Pp. 12; 6 x 9 in.; illustrated. This contains information on the various methods employed in the measuring of gases and shows the application of these meters to producer plants, gas works, etc.

How Anyone Can Make a Jointless, Gastight Furnace Lining is the title of a booklet issued by the Betson Plastic Fire Brick Co., Rome, N. Y., showing how "plastic fire-brick" made by this concern is used in forming one-piece linings for steel boiler furnaces. Pp. 16; 3½ x 6 in.; illustrated.

Smooth-On Instruction Book No. 16. Smooth-On Manufacturing Co., Jersey City, N. J. Pp. 16; 3½ x 6 in.; illustrated. This describes various cements for repairing breaks or leaks in iron pipes, castings, etc., and contains the standard sizes of Smooth-On coated corrugated gaskets for flanged pipes from 2 in. up to 26 inches.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Jan. 17, 1918	One Year Ago	Jan. 17, 1918	One Year Ago
Buckwheat	$4.60	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.10	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	3.90	.....	.....	.....
Barley	3.60	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Bituminous not on market.

	F.o.b. Mines*		Alongside Boston†	
	Jan. 17, 1918	One Year Ago	Jan. 17, 1918	One Year Ago
Clearfields	.....	$3.00	.....	$4.25—5.00
Cambrias and Somersets	.....	3.10—3.85	.....	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.90 a year ago.
*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Jan. 17, 1918	One Year Ago	Jan. 17, 1918	One Year Ago
Pea	$5.05	$4.00	$5.80	$7.00—7.25
Buckwheat	4.30—5.00	2.75	5.50—6.00	6.50—7.00
Rice	3.75—3.95	2.20	4.50—5.00	4.50—5.00
Barley	3.25—3.50	1.95	3.50—4.00	3.25—3.50
Boiler	3.50—3.75	2.20	.....	.....

Bituminous smithing coal, $4.50—5.25 f.o.b.
Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate)	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide		Independent
	Jan. 17, 1918	One Year Ago	Jan. 17, 1918	One Year Ago	One Year Ago
Buckwheat	$3.15–3.75	$2.00	$3.75	$2.90	$4.15
Rice	2.65–3.65	1.25	3.65	2.15	3.35
Boiler	2.45–2.85	1.10	3.55	2.00	....
Barley	2.15–2.40	1.00	2.40	1.90	2.35
Pea	3.75	2.80	4.65	3.70	....
Culm	....	....	....	....	1.25

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.10—3.25
Mine-run	2.40—2.55	2.85—3.00
Screenings	2.15—2.30	2.60—2.75

Smokeless Coals	So. Illinois, Pocahontas, Pennsylvania and West Virginia	Hocking, East Kentucky and West Virginia Splint
Prepared sizes	$2.60—2.80	$3.05—3.25
Mine-run	2.40—2.60	2.40—2.60
Screenings	2.10—2.30	2.10—2.30

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Jan. 17, 1918	One Year Ago	Jan. 17, 1918	One Year Ago	Jan. 17, 1918	One Year Ago
6-in. lump	$2.65–2.80	$3.25–3.50	$2.65–2.80	$3–3.25	$2.65–2.80	$2.50–2.75
2-in. lump	2.65–2.80	.....	2.65–2.80	.....	2.65–2.80	2.25–2.50
Steam egg	2.65–2.80	.....	2.65–2.80	3–3.25	2.65–2.80	2.25–2.50
Mine-run	2.40–2.55	3.00–3.25	2.40–2.55	3–3.25	2.40–2.55	2.25–2.50
No. 1 nut	3.65–2.80	.....	2.65–2.80	.....	2.65–2.80	.....
2-in. screen	.....	3.00–3.25	2.15–2.30	.....	2.15–2.30	2.25–2.50
No. 5 washed	2.15–2.30	3.00	2.15–2.30	2.75	2.15–2.30	.....

Williamson-Franklin rate St. Louis, 87½c.; other rates, 72½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cahaba	2.40	2.65	2.15

Government figures.

[1]Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Calif., Los Angeles—The Nevada-Calif. Power Co., Riverside, plans to build about 300 miles of voltage line. About $300,000. C. O. Poole, Riverside, Ch. Engr.

D. C., Wash.—The Bureau of Supplies and Accounts, Navy Dept., Wash., will soon receive bids for furnishing at various Navy Yards under Schedule No. 1653, 30 sets of motor generators.

Ga., Waynesboro—City plans extensive improvements to its electric-lighting plant, including the installation of one 200-hp. boiler, and one 100-kw., 3-phase, 60-cycle, 2300-volt generating unit directly connected with a switchboard, complete. J. C. Andrews, Supt.

Ill., Chicago—The Lincoln Park Commissioners plan to install a 500-kw., 3-phase, 2300-4000-volt turbo-generator for heating system. C. H. Shepherd, Electrical Engr.

Iowa, Emmetsburg—The Northern Iowa Gas and Electric Co. plans to extend its electric transmission line from here to Dickens. R. J. Mullins, Mgr.

Kan., Sabetha—The City Council plans to change the equipment of the entire electric-lighting plant from single to 3-phase system. C. A. Darby, City Engr.

Ky., Guthrie—The South Kentucky Power Co. plans to build an electric transmission line from here to Lebanon, Tenn. A. F. Trimble, Mgr.

La., Kenner—City plans to issue $10,000 bonds for improvements to its electric-lighting plant. P. Felix, Mayor.

Md., Rising Sun—City has sold $8000 bonds and plans to improve its electric-lighting plant with the proceeds.

Mass., Cambrdge—The Cambridge Electric Light Co. plans extensive improvements including the installation of a 12,500-kw. turbine, two 600-hp. boilers, an ash-handling system and the extension of its switchboard. W. E. Holmes, Newton, Gen. Mgr.

Mass., Gardiner—The Gardner Electric Light Co. plans to install an additional 1500-kw. bank of transformers. C. A. Ware, Mgr.

Mass., Hudson—The Town plans to install a new 600-kw. turbine with a condenser and an additional boiler in its electric-lighting plant. G. A. Brothers, Mgr.

Mass., Pittsfield—The Pittsfield Electric Co. plans to install a 2500-kw. General Electric turbo-generator and two 520-hp. Babcock & Wilcox boilers. W. A. Whittlesey, Supt.

Mich., Sturgis—The Board of Public Works plans to install a 500-kw. auxiliary generating unit. J. S. Flanders, Mgr.

Mo., Cameron—The City Council plans to improve its electric-lighting plant.

N. Y., New York—The Electric Reduction Co., 50 East 41st St., has increased its capital stock from $100,000 to $200,000; the proceeds will be used for additions and improvements.

N. C., Southern Pines—J. T. Patrick is in the market for second-hand electrical machinery in good condition, from about 25 to 50 hp., for water-power development.

Okla., Chandler—The Chandler Electric Co. plans to build a new power house and install equipment. H. G. Stettmund, Jr., Mgr.

Okla., Hooker—City plans to issue bonds for the erection of an electric-lighting plant to replace the one which was destroyed by fire. Loss, $22,000.

Wash., Seattle—The City Council plans to build a substation for the Light Department on B 166, Gilman Park addition. About $20,000. A. H. Dimock, City Engr.

Wis., Amherst—The Amherst Electric Service Co. recently incorporated, plans to build an electric-lighting plant. B. E. Dwinnell, interested.

Wis., Sheboygen—The Badger State Tanning Co. is having plans prepared by Juul & Sixta, Arch., 805 North 8th St., for the erection of an addition to its power house.

Wis., Stebbinsville—The Porter Electric Line Co. recently incorporated, plans to develop the water power and furnish electricity to the rural district here. F. Miller, Pres.

Ont., Port Colborne—A. E. Augustine, Box 116, is in the market for a 15-hp. electric motor with starter.

Ont., Toronto—The Swift Canadian Co., Keele St., is in the market for a 50-hp. locomotive-type boiler.

Ont., Trenton—The Hydro-Electric Power Commission, Toronto, plans to build a transmisison line through the towns of Picton, Wellington and Bloomfield in Prince Edward County; also a 4000-volt transmission line from Bloomfield to Wellington, for which 2 substations will be built. F. A. Jaby, Ch. Engr.

Ont., Windsor—The City Commissioners plan to install 2 new electrically driven pumps in its pumping plant.

Que., Valleyfield—The Montreal Cotton Co. plans to rebuild its power plant which was recently destroyed by fire. Loss $100,000.